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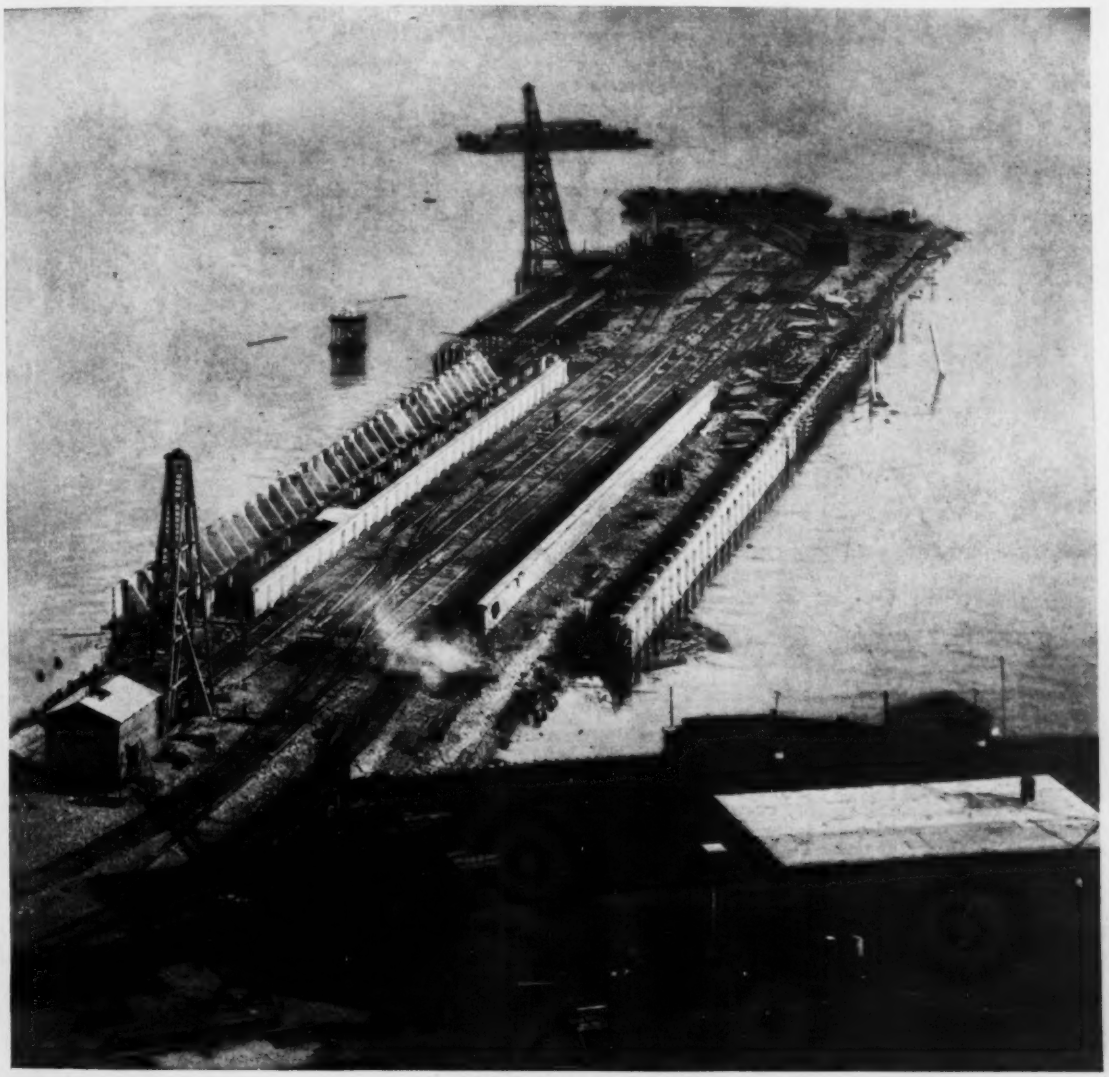

Pier B-C of the Canadian Pacific Railway at Vancouver, British Columbia

Concrete Piles Impregnated with Asphalt for Sea-Water, by George F. Nicholson

Design and Construction of Canadian Pacific Railway Pier, by A. D. Wilder

Water Intake Designed to Meet Special Conditions, by Milton J. Salzman

Long Cantilevers Carry Sixteen Stories of Tall Building

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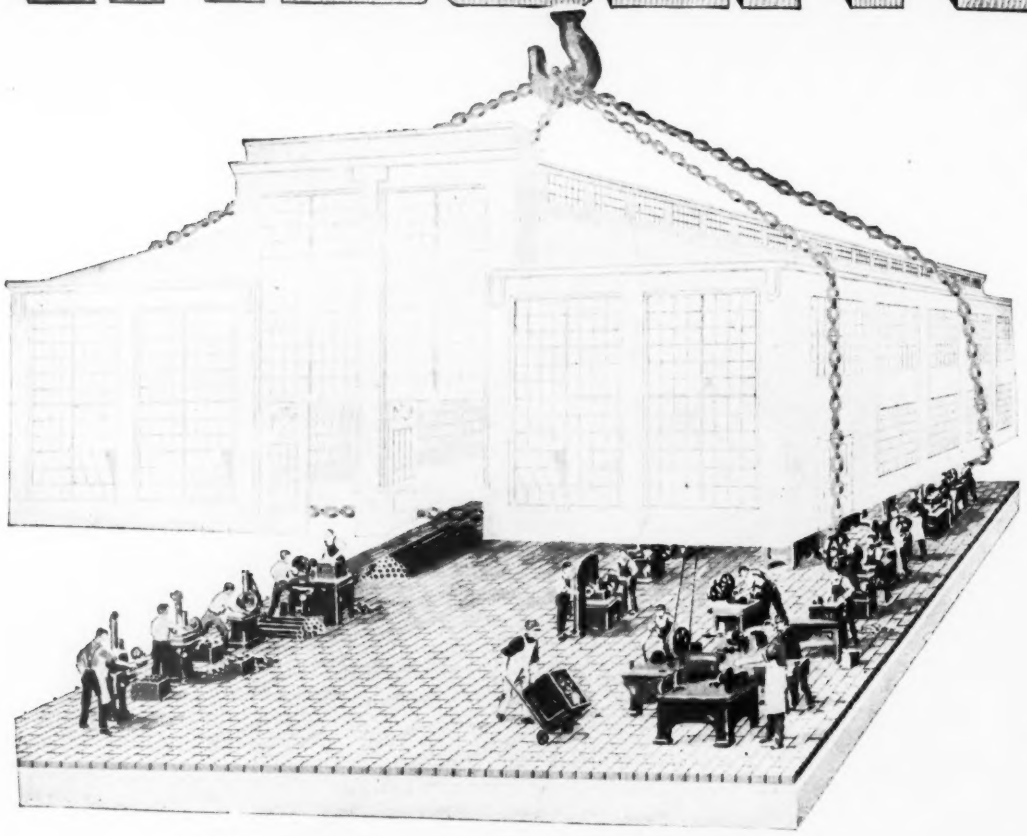

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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FRANK C. WIGHT
Editor

Volume 97 NEW YORK, DECEMBER 16, 1926 Number 25

Recognition for the Engineer

PUBLIC recognition of the individual engineer is very rare. Mr. Stillwell's reference to recent flagrant cases, in his letter on another page, could be duplicated from any engineer's experience. But this obscurity is shared by most professional men, certainly by the engineer's fellow the architect, and to a lesser degree by the author. Just as few know who is responsible for the concept of a great bridge or for the design of a striking monument, so the average reader, who reads merely for pleasure, rarely remembers the name of the man or woman who has labored to entertain him. Those who finally arrive are sometimes honored by recognition; most professional practitioners labor in the shadow of anonymity and must look for honor to their own profession and for reward to the appreciation of those whom they directly serve. This could be borne with better equanimity by engineers, perhaps, were it not that the same careless public often delights to honor for an engineering work the executive and financial director whose approval was necessary to the project but whose genius more often than not lay only in the ability to perceive engineering genius when it was thrust before him. Opportunities to direct public attention to the engineer's submergence come infrequently. Mr. Stillwell is right in urging that the profession take every advantage of such as are offered.

Waterway Logrolling

PRESIDENT COOLIDGE in his message last week to Congress devoted one paragraph to the waterway program which his Secretary of Commerce has been so actively promoting for a year past, and in that paragraph he said: "If the country will be content to be moderate and patient and permit improvements to be made where they will do the greatest general good, rather than insisting on expenditures at this time on secondary projects, our internal waterways can be made a success. If proposed legislation results in a gross manifestation of local jealousies and selfishness, this program cannot be carried out." Almost in the same mail with the President's message came a copy of a letter from the leading spirit in the Mississippi Valley Association to the executive director of the Great Lakes-St. Lawrence Tidewater Association, from which are culled these pertinent sentences: "You have lost the support of the Mississippi Valley Association for the Great Lakes-St. Lawrence project. Men from all parts of the valley have gained the impression that advocates of your project do not desire a possibly competing channel open to commerce from Chicago to the Gulf. Valley men have come to the conclusion that the St. Lawrence project is hostile to the interests of the valley, but that an all-American channel from the Great Lakes to the Atlantic should not be hostile to the valley. Once upon a time we were all ready to help you; now the whole valley is organizing to fight your project to the bitter end." It will take something more than a presidential message to remove logrolling and backscratching from waterway propaganda.

Zoning Decision Welcomed

FROM New Jersey to California the recent decision of the United States Supreme Court upholding city zoning has been heartily welcomed. Among the many editorial comments in the daily press of the country that have come to our attention the nearest approach to disapproval of the decision was a remark in one paper, apropos of the right now established to exclude business from areas zoned as residential, that without business buildings there would be no residences—an irrelevant truism. This country-wide approval of the decision is significant. It is what might be expected in view of the rapid spread of zoning since its advent ten years ago. Now that our highest court has set its approval on zoning as a proper exercise of the police power for the protection of the many against the few, and as an aid to orderly city growth, interest centers on the courts of those states, happily few in number, which have barred zoning from their jurisdiction as an invalid exercise of the police power. The most notable of these are New Jersey, Maryland, Missouri, and Texas. Already the authorities of Newark, the largest city in New Jersey, acting on advice of counsel, have decided to renew enforcement of the zoning ordinance of that city. Doubtless other municipalities in New Jersey and the other states having ultra conservative courts will follow, if they have not already led, in this action. The opinion of the United States Supreme Court in the Euclid, Ohio, case (*Engineering News-Record*, Dec. 2, 1926, p. 916) is so broad and strong in support of the main principles and practices of zoning that it is hard to see how any state court can bar zoning hereafter except through mere stubbornness and subterfuge, and with certain defeat in every case that can be and is appealed to our high court in Washington. Ingenuity may be required in some instances to get a zoning case to the United States Supreme Court but where there's a will there's a way.

Making a Stop Law Absurd

RAILROAD men apparently still believe that to require automobiles to come to a full stop before a railroad crossing is to insure safety and to reduce grade-crossing accidents. *Railway Age* a few weeks ago, for instance, had an editorial note entitled "Why Stop Laws Should Be Enacted," which strongly urges this reform and as an instance of why it is needed, cites the following occurrence: "Recently, at a railroad and highway intersection on the Denver & Rio

Grande Western, an automobile was driven into the side of a slowly moving freight train. While the train crew were moving the damaged car from the crossing another automobile was driven into the opposite side of the train." This shows a remarkable faith in the efficacy of law, a faith which is quite refreshing in these days when so much inveighing is done against the ordinary citizen's disregard of law, but it carries faith to an absurd conclusion. Does any one really believe that a man who would drive an automobile head-on into a perfectly evident freight train is going to be deterred from such an insane performance by the fact that there exists some kind of an ordinance requiring him to stop? Is the fear of the law and its punishment greater than the fear of injury and death?

Road Stone Quarries

RECENT profitable excursions by the Bureau of Public Roads into the borderland problems of road building are excellently exemplified by the study just published of the direct production costs of broken stone. The investigation as outlined in *Public Roads* for October, 1926, bears evidence of having been directed for the uses of the road contractor producer of broken stone rather than for the large commercial quarry operator. This is probably as it should be. Problems of overhead, investment, depreciation, depletion, sales, delivery, and others of major concern to the permanent operator for the market are, in the case of the contractor producer, merged into the general costs and overhead for his entire operation. He is particularly concerned with data on direct production costs and these are given him in this study in more extensive form and better analyzed for his use than they are remembered to have ever before been published. From these statements it may not be concluded that the commercial quarryman has no interest in this study. As a matter of fact all the quarries studied—twenty-three of them—were commercial quarries. Reverting again to the road contractor producer's interest in the findings, attention may be drawn to one conclusion of particular interest. It is: That a relatively small quarry can be operated with direct costs lower than the average of large-scale quarries if good operating intelligence and modern power and equipment are employed.

Hudson Bridge Assured

IN FIVE or six years, more or less, Manhattan Island will be connected directly with the mainland westward by a bridge. The last obstacle to the construction of the 178th St.-Fort Lee bridge was removed last Friday by the sale of bonds to pay for the work. Prices and terms were realized that are only slightly less favorable than those of good municipal bonds, so that financial faith in the proposed bridge is strong indeed. It is true that only part of the full cost is covered by the bonds so far sold, but as these have no preference over the remainder of the authorized issue the present sale really involves the entire issue of $60,000,000, and the full sum may be considered to be available in effect. As the design of the bridge has already been made, in sufficiently complete form to develop all the technical problems and to show that there will be no unprecedented difficulties, both money and method are in hand. No hitch in construction is to be foreseen, for a competent organization has been formed to carry out the work, headed by O. H. Ammann, of long experience in the field of large bridges. Thus, the age-old dream of bridging the Hudson, of which we spoke in our Nov. 18 issue (p. 814), is now actually realized. For the city of New York it means a new era of existence. The transformation and development that will come to the great metropolis when the Hudson River barrier is overcome promises to exceed what even the liveliest imagination now can picture.

The Metamorphosis of the Port Authority

THAT the National City Co. is willing to lend $20,000,000 to the Port of New York Authority for the start of the 178th St. bridge across the Hudson at a rate of approximately 4.25 per cent is testimonial of the high regard of the banking world for the essential integrity of that unique body. So far as the law reads the Port Authority, which has no powers of levying taxes, is alone responsible for the security of those bonds, and the funds for their repayment and for the repayment of the $14,000,000 bonds already issued on the two Staten Island bridges must come from the tolls collected on the bridges. The States of New York and New Jersey, and their respective subdivisions, are not obligated in any way. And yet the bankers must believe that the risk taken is comparable to the risk with any government activity, for the rate at which they are willing to lend is comparable to the rate on government securities and materially below that at which money can be borrowed for private toll bridge ventures. At least if they do not believe that themselves they must feel that they can convince the purchasers of the bonds that this is, in effect, a public undertaking backed up by the financial authority of the two states. The ready sale of the bonds, then, is a triumph for the Port Authority idea.

This Port Authority has come a long way since the days of the bi-state committee which recommended its formation. It had its initiation in an effort to devise some way to improve the handling of freight to and from the metropolitan area of New York City; its only constructive work has been the promotion and construction of highway bridges which may facilitate to a degree the handling of freight but which primarily are passenger carriers having practically no effect on the major problem of railroad freight.

The bi-state compact which is the enabling act of the Authority carried with it as necessary to its legalization the adoption of a "Comprehensive Plan" for the development of the port. This plan had several broad clauses, under which the Authority could do a number of things, but its whole purpose and intent, evident in every line and traceable in the whole history of its development, was to provide a system of railroad lines and terminals whereby the rail- and water-carried freight passing through the port would be expedited and the cost of its carriage reduced. There were several belt-line railways, a tunnel or two under the Hudson and the Bay, a subway in Manhattan and an automatic electric railway line to traverse the whole. Nowhere in the compact or in the "Comprehensive Plan" is there reference to highway bridges.

At first the Port Authority tried to realize its ideal scheme. An attempt was made to take over as one of its belt lines an existing line in New Jersey; a strong, and successful, fight against the city's tunnel under the

Narrows was made on the ground that it unnecessarily and unsatisfactorily duplicated the Authority's tunnel farther north; the New York Central's proposal for a West Side improvement was fought on similar grounds. Studies as to proper freight handling methods continued, new proposals for terminal warehouses and store-door delivery were given constant publicity, and the much criticised and highly nebulous automatic railway was tacitly, at least, abandoned. But in actual work toward an improvement of the freight handling facilities of the port, for which be it remembered the Authority was really formed, absolutely nothing was done. And the years ran on, and salaries had to be paid and the two states had to pay them.

Then the Authority took up the highway bridges—two connecting Staten Island with New Jersey and one tying Manhattan to the same state. There was apparently warrant in the law for this, under a clause which permitted the authority to "make plans for the development of the said district, supplementary of any plan theretofore adopted," provided the two legislatures approved such plans. The legislatures were amenable and the highway bridge projects were launched, with the success already noted. The Authority has therefore become an active, constructive body, with some thirty millions of dollars at its disposal and with many more millions at its call—and its sole active function is the building of highway bridges.

The bridges to be built are needed. There is every prospect that they will be successful toll enterprises. The Port Authority will probably be able to build them and to operate them as efficiently as could any other state or interstate body and it is doubtful if by private venture or by any other public device could these necessary crossings have been provided for a number of years. Pragmatically, therefore, what has happened is highly desirable, for so far as can be seen the scheme is going to work.

But to students of government the development is most interesting, for it marks the rise of a new form of public enterprise, novel in its make-up and far-reaching in its power. Ordinary government bodies are subject to the vagaries of the voter. Their personnel is controlled, and being controlled their acts are always performed with a view to future consequences at the polls. Further than that their authority is limited and their source of funds subject, either by appropriation or authorization, to the will of the electorate.

The Port Authority is subject to few of these restrictions; its members are appointed and are responsible to no one; its funds are limited only by the practicability of its schemes for producing returns on those funds and its scope is as extensible as its own interpretation of its enabling act. It is the most fortunate of governmental bodies. But its good fortune should not lead it to forget for what purpose it was formed. Building highway bridges will occupy its time, the financing of such bridges will give it funds wherewith to work, but such bridges will do but little to facilitate the handling of freight in the port of New York. The members of the Port Authority, if they care to read the history of their organization, can readily find that that is the reason for its being.

It was not to be expected that the Authority could immediately transform the port, but six years is a fair length of time and nothing constructive has been done yet. As time goes on such inertia becomes something worse. Doing nothing is also keeping other people from doing something. A few more years of interference with private port initiative with no substitute public activity will make it only too apparent that the port of New York is suffering rather than benefiting from its new control and the demand for a return to conditions of free competition in port development will be strong. The Port Authority will do well not to delude itself into believing that building bridges is its job.

Control of Bathing in Water Supplies

HOW far to go in the prohibition of bathing in lakes and streams drawn on for municipal water supplies is a troublesome question. "Pass a law forbidding all such bathing," the single-minded protector of water supplies declares. In those of our states where such bathing is a serious problem this is easier said than done; and if done, how enforce the law? The penetration of even remote water gathering grounds by hunters, fishers, hikers, automobilists and campers, the buying up of abandoned farms for summer if not year-round homes, and, more serious still in some regions, the establishment of public bathing and camping places on streams, lakes and ponds, is yearly adding to both the urgency of the problem and the difficulty of meeting it.

For several years past bathing in certain New Jersey waters used for municipal supply has caused much anxiety. Talk of obtaining state prohibitory legislation has not been extensive or strong enough to obtain legislative action—perhaps because the legislators believe that sufficient power is already vested in the State Department of Health and the municipalities. Repeated appeals to the State Board of Health to "do something" produced no results until a decision was made to add to its State Sanitary Code a chapter on bathing in sources of public water supply. This new chapter (reprinted on p. 1012 of this issue) is well worth the attention of public health and water-works authorities, sanitarians and publicists in any other state where the same problem exists and has not yet been fully met.

The evident intent of these administrative regulations, enacted by legislative authority, is to make it possible for the State Department of Health, acting under the police power, to prohibit bathing in sources of public water supply whenever it threatens to endanger the public health, regardless of riparian or prescriptive rights. How far this can be carried, especially as regards bathing places which antedate the use of a stream or lake for public water supplies, the courts are likely to be called on to decide. The presumption is in favor of a large measure of protection to the public, without compensation, but this new chapter of the New Jersey Sanitary Code will need to be administered with a large measure of discretion.

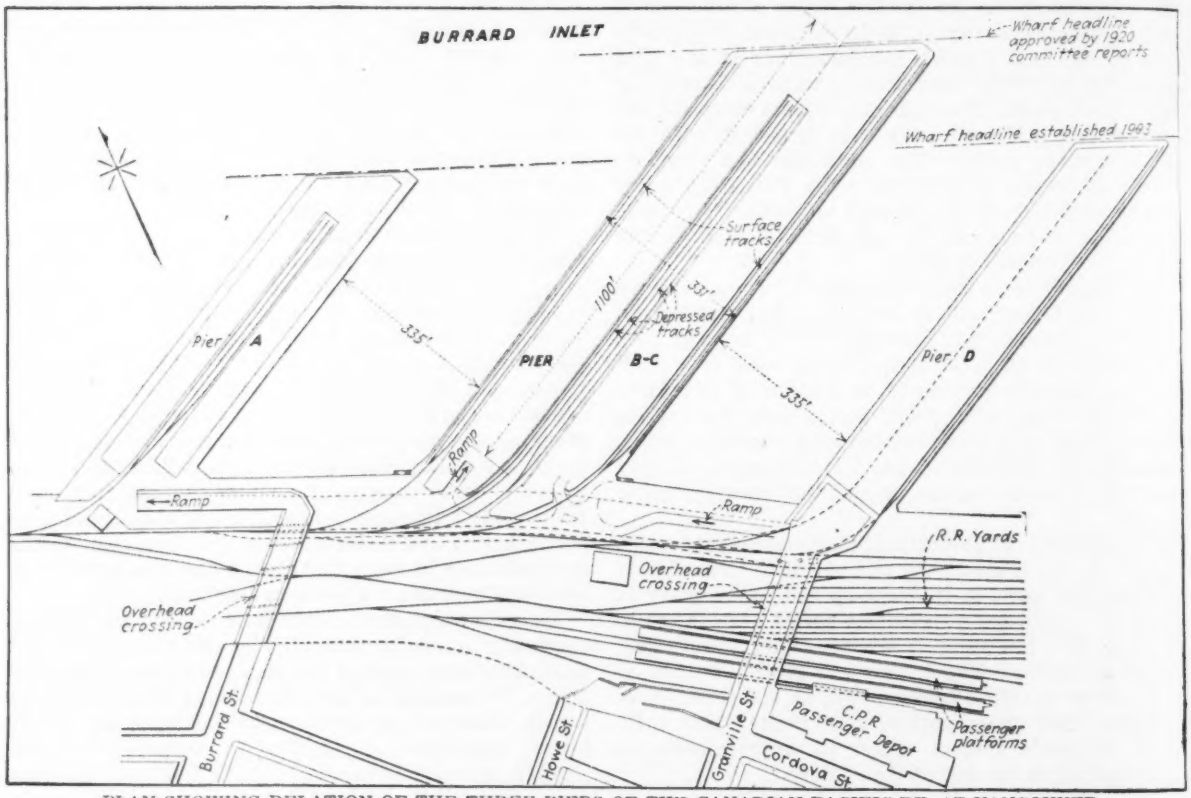
Any uncertainties as to how the courts may regard attempts to deprive property owners and others of what they have assumed to be undoubted bathing rights, without compensation, does not affect the soundness of the principle that the regulation of bathing in sources of public water supply should not be effected by statutory prohibition but case by case, on its merits, by an administrative authority on the advice of competent technical investigators. Whatever the cost of the protection finally afforded may be the burden, except for the investigation antecedent to the prohibition, should rest on the purveyors of water, to be passed on to the consumer.

Design and Construction of Pier "B-C," Canadian Pacific Railway, at Vancouver

Concrete Substructure; Upper Deck for Passengers—Soft Mud at Site Replaced by 1,373,000 Cu.Yd. of Sand and Gravel Into Which Piles Were Driven by 17-Ton Hammer Aided by Jets

By A. D. Wilder
Vice-President and Chief Engineer, Sydney E. Junkins Co., Ltd.

TO ACCOMMODATE its own and other trans-oceanic ships the Canadian Pacific Ry. has just completed at Vancouver, B. C., a concrete pile pier, 331 ft. wide and 1,200 ft. long. This structure, known as pier "B-C," is the result of combining earlier plans for two separate piers, "B" and "C," which the railway company at one time intended to construct between their existing piers, "A" and "D." Piers "A" and "D" are of creosoted pile construction. It was at first proposed to build pier "B-C" of similar construction but an estimate made in the early part of 1923 showed that the cost of creosoted piling and timber had so increased since 1917 when pier "D" was built that on a basis of an 18-year life for a creosoted pile substructure and a 40-year life for a reinforced-concrete substructure, figuring interest at 5 per cent and considering insurance and maintenance charges, the concrete construction was cheaper.

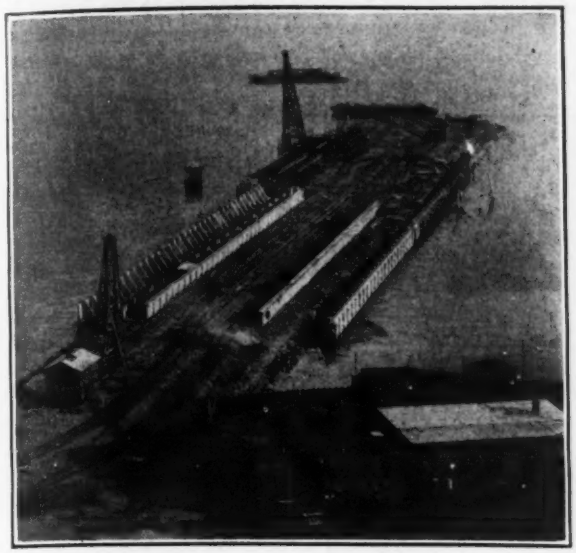


PLAN SHOWING RELATION OF THE THREE PIERS OF THE CANADIAN PACIFIC RY. AT VANCOUVER

Before deciding on final design, various types of concrete structures were considered in the light of foundation conditions. Solid hardpan underlies the site, as shown by the test borings plotted in the accompanying drawing, at depths ranging up to 200 ft. at the outer end of the pier. The water depth at the outer end was about 60 ft. and a layer of soft mud, for the most part about 40 ft. thick, overlay the stiff clay and other material that was considered suitable for foundation.

Pier "D" had been built on an almost identical foundation by placing a gravel core fill, bringing the fill up to above low water along the center line of the pier and squaring off the slopes with creosoted pile construction to form the outer sides of the dock. The inner end of that pier was built in 1914 and the outer end in 1917. Levels run in 1923 showed no settlement at any place. With the depth of hardpan mentioned this core fill type of construction is cheaper than the alternative of sinking reinforced concrete caissons.

In planning the new pier, consideration was given to the possibility of squaring off the slopes of the fill to form the sides of the dock with some type of retaining wall which would make it possible to form the entire pier of solid fill. Although estimates showed that the cost of such construction would probably be as cheap as the type of concrete pile construction finally used, the solid fill was not selected because of the uncertainty in the action of a sloping gravel fill under the toe of such



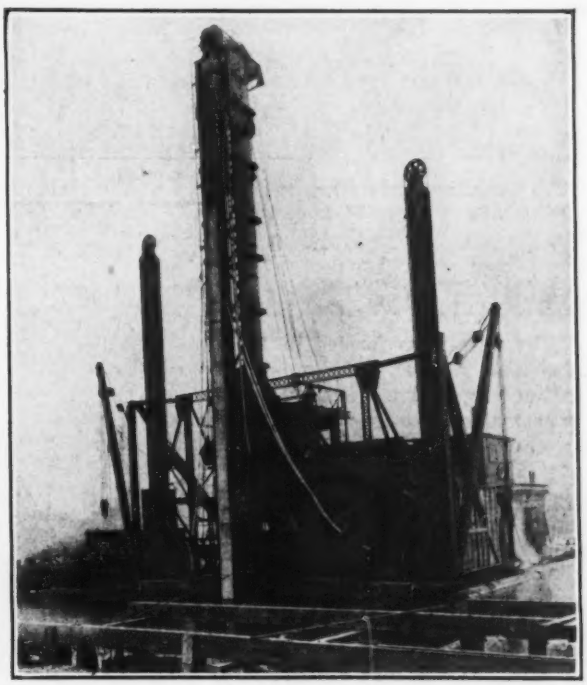
EARLY CONSTRUCTION ON THE NEW PIER AT VANCOUVER
Note partially completed concrete buttress walls. Four depressed tracks are located on the fill center line.

a retaining wall. The general type of design previously used on pier "D" was therefore adopted, using concrete in place of creosoted piles.

In the construction of pier "D" the core fill had been dumped directly into the mud, the dumping being continued until the fill came to rest. Since pier "B-C" was to be of concrete construction, it was thought advisable to excavate as much as possible of the underlying mud before placing the fill. Accordingly in 1919 some 620,000 cu.ft. of soft mud was removed from the site of the pier and about 843,000 cu.yd. of gravel fill had been placed when work was temporarily discontinued. In 1923 work was again resumed and the fill was completed by placing an additional 530,000 cu.yd. of gravel. The material for this fill, obtained by dredging in the First Narrows at the entrance to Vancouver harbor, consisted of sand and coarse gravel. This was deposited in the water from dump scows and took a natural slope of about 1:2½. The center of the fill was raised to the required grade above high water by overcasting with a clamshell bucket.

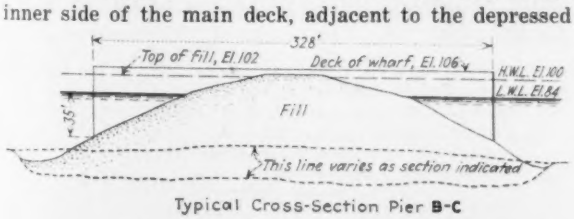
It was decided to rest the concrete deck slab at the inner side of the main deck, adjacent to the depressed track area on the center of the pier, directly on the gravel fill. This was accomplished by constructing a heavy counterfort type retaining wall some 30 ft. outward from the light retaining wall required at the edges of the depressed track area. Both of these retaining walls were founded on concrete piles. The bottom slab of the counterfort retaining wall was placed at an elevation a little above mean tide, not only so that all concrete could be poured in the dry, but also to provide an unrestricted area under the wall for the drainage of the retained fill at low tide.

This prevented the possibility of a hydraulic head being created at low tide in the fill, as would happen should no drainage, or drainage through weep holes only, be provided. It was feared that a hydraulic head in the retaining wall would tend to wash out the fine stuff from the enclosed gravel, ultimately causing settlement. The purpose of this outer buttress wall and of the fill retained by it was to give a heart to the whole structure by furnishing anchorage and lateral strength to the pile-supported deck system.

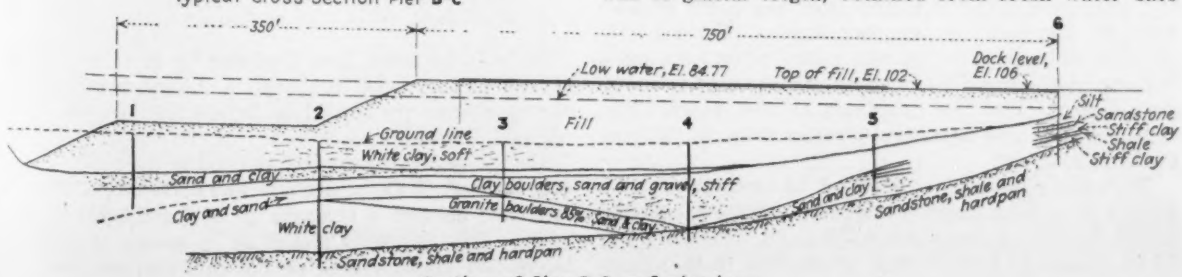


"THE TARZAN" FLOATING PILEDRIVER BUILT FOR THIS JOB
Scow with piles at left. Note derrick booms for delivering piles to leads which are designed for piles 23 in. square and 86 ft. long.

Sand and gravel used in the concrete for pier "B-C" was of glacial origin, obtained from fresh water bars



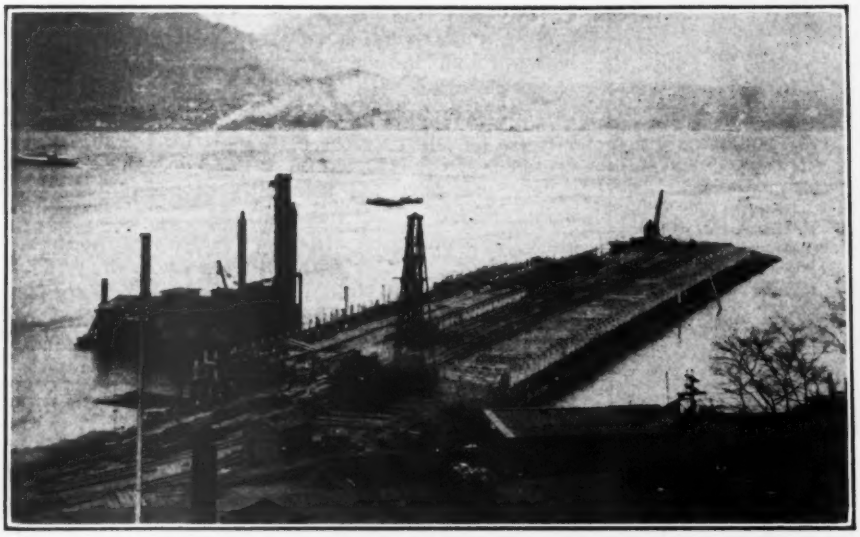
Typical Cross-Section Pier B-C



Section of Pier B-C on Center Line

RESULTS OF TEST BORINGS AND CROSS-SECTION OF FILL

about 50 miles above the mouth of the Fraser River. It was transported to the pier in scows and unloaded by means of a stiff-leg derrick to bunkers located at the shore end of the structure.



ABOVE—PILE-DRIVING OPERATIONS UNDER WAY

Concrete piles were driven into the sand and gravel fill with a 17-ton hammer, aided by jets.

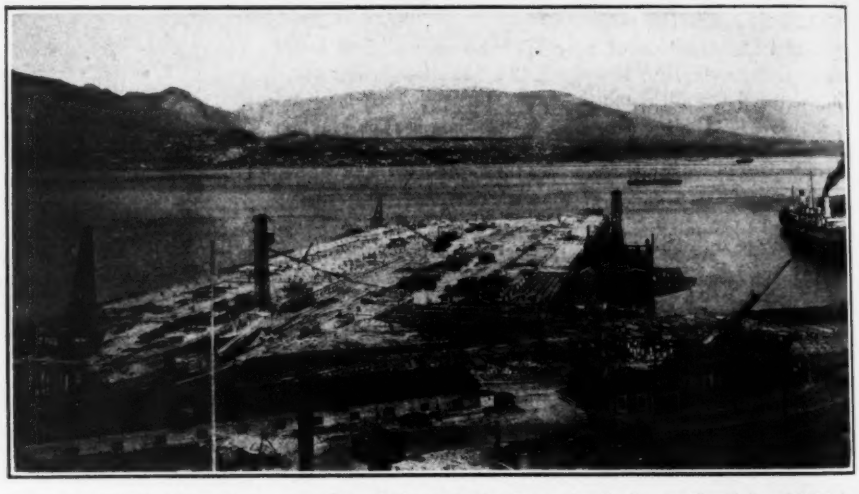
The piles were formed in a casting yard at the shore end of the pier where limited area made space economies necessary. The piles were cast horizontally, those in the first pour being separated by the width of a pile so that when the forms were removed it was possible to cast another set in the spaces between the first set using grease to prevent bonding. A platform was then placed over the first tier and the process repeated, the piles being cast three and four tiers high.

In pouring concrete in the casting yard a 40-ft. tower for delivering to a chute was located at the front end of the car, but in pouring the pier deck in order to reach all parts from the central tracks, a 75-ft. tower was substituted. A mixer of ¾-cu.yd. capacity was mounted immediately behind the tower and a small derrick placed in the center of the car was used to dump the aggregate into the mixer from the batch buckets brought alongside on another track. Cement was brought to the rear of the mixer car in box cars and a belt conveyor alongside the mixer car was used to transport cement from the car doors to the mixer. The concrete hoist was operated by motor drive at the rear of the mixing car.

With this plant about 130 cu.yd. of concrete could be poured in an 8-hr. shift; running two shifts per 25-day month the average pour was 5,500 cu.yd. Fifteen piles, 23 in. square and 73 ft. long, or 60 piles 15 in. square and 20 ft. long, were the average for an 8-hr. run of the plant. In cold weather the aggregate was heated in the buckets by steam jets, steam being obtained from a small donkey boiler placed on a flat-car just ahead of the mixer car. The fineness modulus for the gravel used averaged from 7 to 7.5 and for the sand from 2.5 to 3. The fineness modulus of the combined aggregate averaged 6.0. Concrete for the piles was made in the proportion of one part of cement to 4 parts of aggregate by volume, this mix generally approximating a proportion of 1:5¼ by weight. Four 6x12-in. test cylinders were made each day, two being cured at the laboratory and the others placed alongside the piles to cure in the field. After 28 days the cylinders were tested to failure. The results of these tests for a typical month, July, 1925, in which 88 cylinders were tested, are typical of results for the entire job. The results of these tests are:

BELOW—CONCRETE SUBSTRUCTURE NEAR COMPLETION

Note concreting car in left center with tower and chutes for pouring floor system.



	lb. per Sq. In.
44 cylinders cured in laboratory:	
Average ultimate strength 28 days (44 cylinders)	4,560
Average ultimate strength for highest five....	5,415
Average ultimate strength for lowest five....	3,780
44 cylinders cured in field:	
Average ultimate strength 28 days (44 cylinders)	3,825
Average ultimate strength for highest five....	4,570
Average ultimate strength for lowest five....	3,145

It is to be noted here that results of tests such as these will vary considerably with the manner in which the specimens are headed up before they are placed in the testing machine.

Before being transported the piles were allowed to cure at least 40 days. No pile was driven until the test specimen showed a strength of at least 3,000 lb. per sq.in. The piles were picked up by means of a 40-ton locomotive crane, placed on flat-cars and run under a large stiff-leg derrick erected on a jetty wharf which

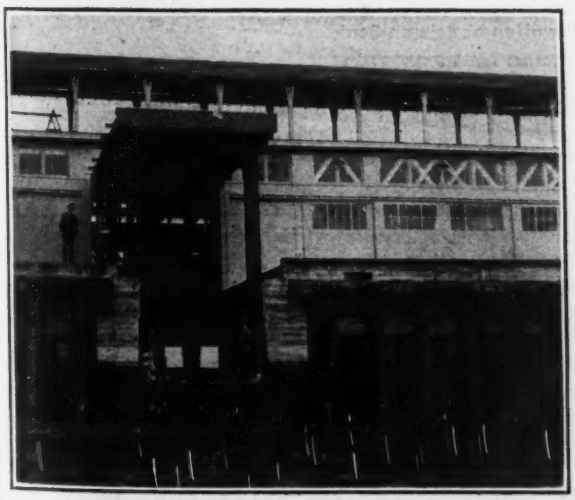
transferred the piles from the cars to scows which fed the skid-driver and the floating driver with piles.

The amount of reinforcing in the piles varies with the size and length. In the largest piles eight 1¼-in. diameter plain bars were used—the 4 corner bars extending the full length of the pile. An effort was made to reduce the amount of reinforcing by using a supporting cradle when handling the piles, but this was found both complicated and impracticable because of the limited headroom under the booms of the locomotive cranes and under the derrick of the driver. Therefore a 2-point suspension was used and the reinforcing made strong enough to withstand this.

The smaller piles were driven without jetting, but where jetting was used, both inside and outside jets were employed. For the outside jets 4-in. pipes were shoved down on opposite sides of the pile. The tips of these pipes were fitted with cast-steel nozzles which discharged about one-third of the water vertically downward, the other two-thirds discharging in an upward direction.

Considerable difficulty was experienced in keeping the points of these jets at the proper place at the bottom of the pile, and also with the tendency of the pile to run off line. The piles equipped for internal jetting had a 4-in. diam. channel cast along the axis of the pile from the toe to a point where connection was made to the jetting hose. A special nozzle was cast in the toe of the pile, which forced the water to flow vertically up the sides of each face of the pile as well as down into the fill.

SIDE VIEW OF THE PIER ALMOST COMPLETED
Note one of the bridges over marine elevators partly raised. A second marine elevator is close to temporary gravel bunker and derrick.



CLOSE VIEW OF MARINE ELEVATOR, OUTBOARD END
Illustrating how deck is raised to clear elevator shaft. Deck is designed to carry two railroad tracks.

The piles used varied from 15 to 23 in. square in section and from 20 to 73 ft. in length. A total of about 6,000 piles was required, of which about one-half were driven with a skid-driver, employing either a No. 0 Union steam hammer or a No. 1 Vulcan hammer, the Vulcan hammer having been remodeled to fit the same leads as the Union hammer.

The remainder of the piles were driven by a floating driver, the "Tarzan." This driver was originally built for use on the construction of a concrete pile pier at Halifax, Nova Scotia. Since 1915 when that pier was completed, the driver had been lying on the beach at Halifax and its hull and most of the steel work within 18 in. of the deck had deteriorated beyond re-use. However, the driver was dismantled and the leads, spuds, engines, and other of its parts fit for re-use were transported to Vancouver and there reassembled on a new hull, built for the purpose, of Douglas fir. In the reassembly, the over-all length of the leads was increased 15 ft., new oil-burning boilers were installed and pumps for jetting, with a combined capacity of 2,000 g.p.m. against a pressure of 250 lb. at the pump, were added. The design of this driver was described in *Engineering Record*, May 30, 1914, p. 612. The leads are designed

for a No. 00 double-acting Union steam hammer. The weight of the striker part, which operates under a pressure of 80 lb. per sq.in., was 4,500 lb. while the weight of the hammer, complete with the follower, frame, brackets, etc., was 17 tons.

The gravel fill at the pier site, due to its character and to having been deposited through water, had settled most compactly. In the beginning considerable difficulty was experienced in driving piles into the fill without serious damage. The piles were driven with a cast-steel follower 4 ft. long into which projected the reinforcing bars that extended above the head of the pile. On top of this follower there was the usual recess holding the customary hardwood cushion block.

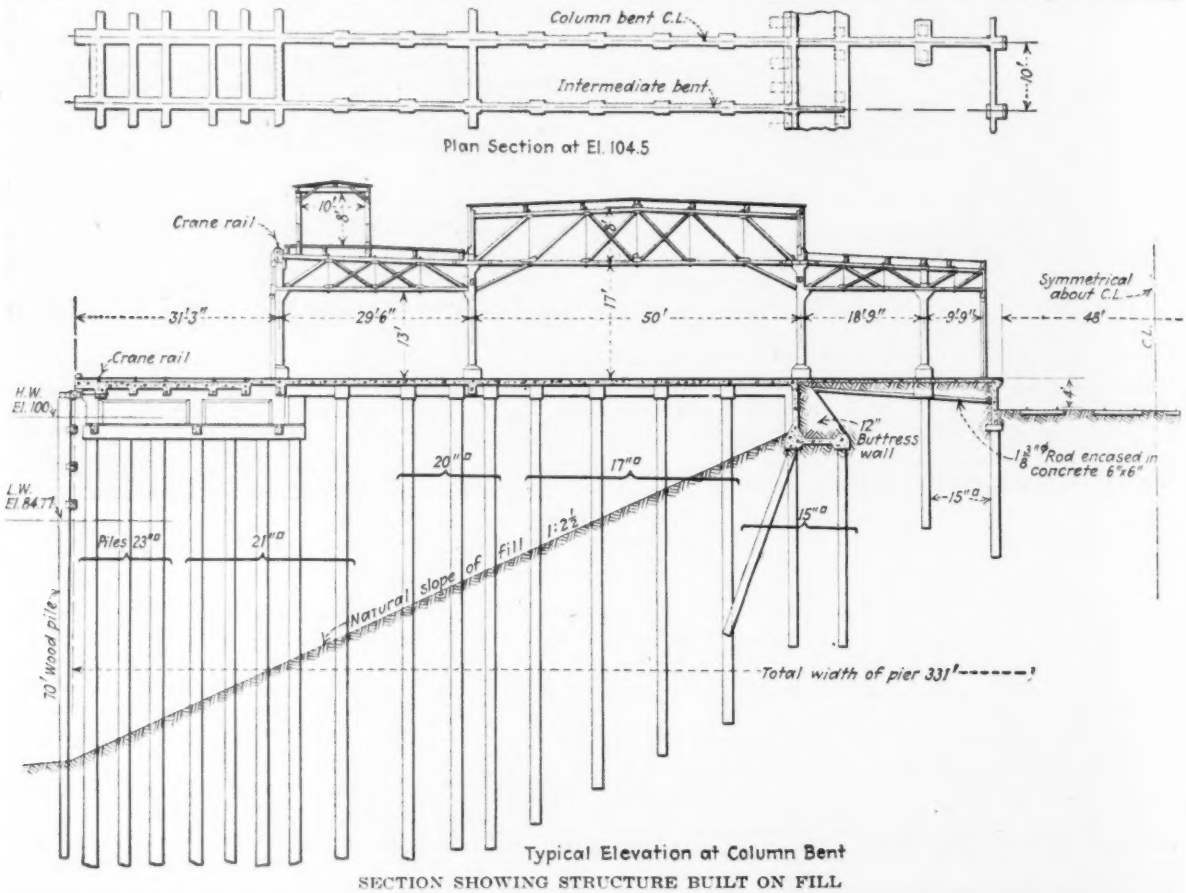
Some of the driving on the Halifax pier is reported to have been hard, and it is interesting to note that the cushion block as used on the Halifax pier wore completely down before driving of the first pile on pier "B-C" had been completed, thus allowing the hammer to strike the edges of the follower, seriously jarring both hammer and follower. This difficulty was overcome by doing away entirely with the hardwood cushion block, filling the recess in the follower head with steel plates and placing on the top of these plates one 2-in. piece of Western spruce to take the blow of the hammer. This 2-in. piece of spruce did not last long, but it required little time to replace a battered piece with a new one.

Three shifts were worked on the piledriving and the exhaust of the double-acting hammer made considerable noise, so that some of the hotels in the nearby district attempted to prevent night work by an injunction. The sound of this exhaust was so materially lessened, however, by the attachment of a home-made muffler, designed along the lines of the common gas engine muffler, that these complaints were withdrawn.

The character of the fill, as regards driving, proved to be rather spotty, so that a penetration of as much as 30 to 35 ft. could be obtained with some piles, whereas but a short distance away the piles could be driven to a penetration of only about 20 ft. Since it was impossible to predict with accuracy the amount of penetration that would be obtained, a great many of the piles had to be cut off in order to obtain the required level of the pile head. The portions of the piles thus cut off were used to build a riprap facing on the fill to prevent wash between tide levels.

After some experimenting the piles were formed with a small point and a long taper. The blow of the hammer was carefully adjusted and great care was taken that the floating driver did not move on its spuds while the pile was in the leads. Under these conditions it was found that practically no cracks appeared in the piles. After each pile was driven it was carefully inspected from top to the ground line by divers. There was no difficulty in seeing cracks under water although they usually appeared as very fine lines. In a few cases the edges of the cracks spalled off.

Out of the 6,000 piles driven cracks were found in 250, and of these cracked piles two-thirds were driven during the experimental stage of the work. Cracks which occurred above low water were repaired by chipping a groove along the crack and then shooting on a



SECTION SHOWING STRUCTURE BUILT ON FILL

heavy coat of gunite. It was not believed probable that deterioration would result from hair cracks below low water, but to avoid danger due to this cause all cracks below low water were also repaired. This was done by clamping a cylindrical steel box 4 ft. long around the pile, centering on the crack, placing wire mesh reinforcing inside the box, stopping all cracks by divers, and then pouring a 5-in. shell of concrete.

To avoid deterioration in sea water it was important that the concrete used in the piles be dense. To test the permeability of the concrete, pieces were broken off some of the piles after they had been cured. These pieces were clamped over the end of a water pipe and subjected to a water pressure of 115 lb. per sq.in. for 24 hours. Although some of these pieces were less than ½ in. thick no water was forced through them.

Due to the large number of ships which now use fuel oil and the wastage that occurs in this harbor, a certain amount of this oil is always floating on the surface of the water. Within a few weeks after the piles were driven at pier "B-C" the surfaces between the low- and high-water marks were covered with a film of fuel oil. It is believed that this film of oil will protect the surface of the piles by preventing alternate wetting and drying of the concrete, a principal cause of disintegration.

Two separate tests were made to determine the bearing value of concrete piles driven into the gravel fill. In the first test a 15x15-in. pile, 30 ft. long, was driven to a penetration of 27 ft. 9 in. Using the No. 0 Union hammer with steam pressure at 90 lb. per sq.in., this pile penetrated 10 in. under the last 50 blows. This pile when loaded with 52 tons showed no settlement. In the second test two 17x17-in. piles 47 ft. long were also driven with the same No. 0 Union hammer, one to a penetration of 15 ft. 6 in., the movement in the last 50 blows being 1½ in. and the other to a penetration of 14 ft. 3 in., the movement in the last 50 blows being 5 in. A load of 86 tons placed on each of these piles and left for five weeks caused no settlement.

Pier "B-C" carries two single-deck sheds from the head-house at the shore end the full length of the pier. These sheds are 109 ft. wide and lie on either side of a central depressed area containing four tracks over which no roof is provided. The head-house is two stories high, providing on the lower floor storage space and driveways into the shed and on the upper floor passenger-handling facilities, baggage, office and store rooms for the Canadian Pacific Ocean Steamship service.

The superstructure in the single-deck portion is of wood while steel-frame construction has been used chiefly in the double-deck portion at the head-house which spans the railway tracks leading onto the pier. A steel-frame viaduct with a concrete roadway connects the upper deck of the head-house with the viaduct extensions of Burrard and Granville Sts. while ramps connect this level with the lower deck of pier "B-C" and of piers "A" and "D." A promenade is constructed down each side of the pier, leading from the head-house over the roofs of the freight sheds. Connections are made from this promenade to the ships by a long gangway so that passengers may embark and disembark without hindering freight-handling on the lower deck.

Two railway tracks and a traveling gantry run along the deck outside the sheds on either side of the pier. Continuous sliding doors are installed on both sides of the sheds so that freight may be taken directly through the sheds from the ship's slings to cars. The columns supporting the roof on the inboard side of the shed set back 12 ft. to avoid the need of closely spotting cars.

Eight marine elevators are installed on the outboard sides of the pier; three on each side, and two on the end. Most of the coastwise boats load and unload from side ports, in the same manner as do river boats, while the ocean-going steamships operated by the company, with the exception of the "Empress of Australia," use side ports for the quick handling of silk and baggage. These elevators, which are known as the "Barlow" type,

CONSTRUCTION VIEW SHOWING TIMBER TRUSSES

are so constructed that when the elevator is lowered to the proper level a platform projects out from the outer end of the elevator into the side port of the boat, thus bridging the gap between the boat and the elevator. Freight trucks, automobiles or other vehicles to be moved from the deck of the boat can then be run over this gangway onto the elevator. As the elevator is lifted, the projecting apron automatically moves inward under the elevator platform to clear the ship's side.

The elevator is designed so that it can be raised not only to the level of the main deck but to as much as 4 ft. above it, with elevator platform level with the floor of any truck or wagon waiting to receive freight, thus facilitating transfer of heavy loads. The elevator is also designed so that the inboard end can be hinged at main deck level and the outboard end lowered into the side port of a ship, thus permitting the elevator to serve as a slipway when it is desirable to use belt conveyors for handling hand trucks or package freight.

In order to make the two railway tracks and the outer crane rail continuous over these elevators so that they could be used when the elevators were not in operation, it was necessary to construct the deck at this point as a steel bridge spanning the elevator well. Mechanism is provided so that these bridges may be hoisted vertically a distance of 15 ft., thus clearing the elevator shafts when the elevators are operated.

The deck of the pier, the viaduct and the ramps are designed to meet the worst of three conditions: (1) A uniform live-load of 600 lb. per sq.ft.; (2) one standard 20-ton or (3) any number of 15-ton trucks. To the last two conditions impact is added on the basis of a minimum of 30 per cent as provided in the highway bridge specifications published by the American Society of Civil Engineers in March, 1924. Storage space on the upper floor of the head-house is designed for a uniform live-load of 300 lb. per sq.ft., the baggage room being also required to carry one 10-ton truck.

The pier was designed and built by the Sydney E. Junkins Co., Ltd., under the direction and with the co-operation of offices of the Canadian Pacific Ry.

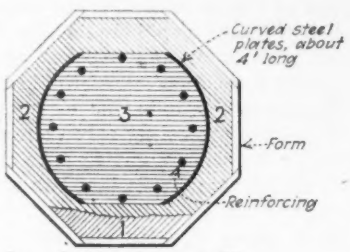
Concrete Piles Impregnated With Asphalt for Sea-Water Use

Low Temperature Impregnation Method Adopted for Los Angeles Harbor After Observation of Concrete Deterioration

By George F. Nicholson
Harbor Engineer, Los Angeles, Calif.

This is an extract from a paper entitled "Deterioration of Concrete in Sea Water and Preventive Methods," presented before the 1926 convention of the Pacific Coast Association of Port Authorities. The parts of the paper not given here are devoted to the general subject of sea water effect on concrete of various types of design.—Editor.

MARKED deterioration has developed in concrete used in the Pacific Coast ports. Disintegration evidently began a short time after the concrete was placed, and although the progress was apparently slow for the first few years, yet there appears to have been a more rapid advance in the rate of decomposition after the age of approximately seven or eight years has been attained. This deterioration takes place chiefly between the extreme low water line and the top of the piling, and on the under side of concrete floor systems and concrete beams. The salt spray, heavy fog and salt-laden air appear to be the causes contributing to deterioration above the high water line.



MAKEUP OF ASPHALT-IMPREGNATED PILE

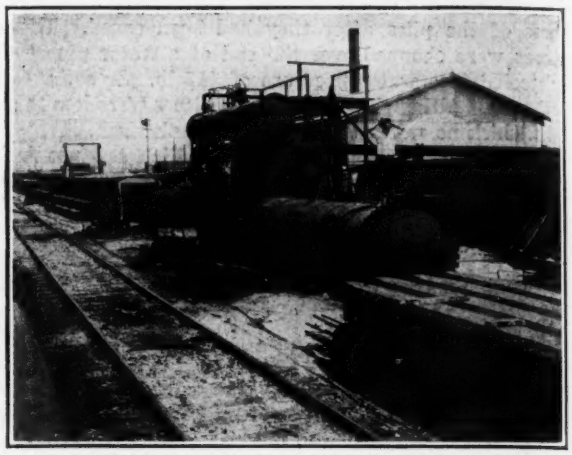
Proportion used in 1 and 2 is same as in 3 but mix is dryer. Portion 1 is placed first, then curved steel plates are put into the forms and 2 and 3 are poured at the same time, on opposite sides of the plate. Pneumatic hammers are used. The steel plates are withdrawn as the concrete level rises. Thus in inexpensive manner a shell is afforded which will take asphalt under a treatment not severe enough to affect the central portion 3 at all.

In Los Angeles, plain precast concrete piling, both untreated and painted, and also the same type of piling containing different admixtures and compounds for producing as dense a concrete as possible, have shown a serious deterioration. This deterioration was noticeable at the age of approximately eight years, but has progressed much more rapidly during the past three to five years, some of the concrete piling being eleven years in place, while others have seen fourteen years of service. These results indicate the need of pressure treating of piling with asphalt or other agents, to seal the pores of the concrete thoroughly for an adequate distance in from the surface of the pile.

Experimental Asphalt Impregnation—A considerable amount of experimental work has been conducted in Los Angeles harbor during the past few years, with the view of producing an adequately protected pile that would have great length of life. The lean concrete pile, fully impregnated with asphalt and commonly known as the "Duocrete" pile, a patented product, was one of the first results of research in this direction. A number of these piles have been used in the past in the public terminal facilities, as well as private wharf facilities, in Los Angeles harbor, but not in the past two years.

The criticism directed against the "Duocrete" pile has been that it was made of a lean and therefore porous mixture, to ensure full asphalt penetration, and that in the treatment at high temperatures at least part of the water of combination was driven off, thus resulting in a weaker concrete. The present Harbor Board and Engineering Department believe this criticism fully justified.

Extensive laboratory and field tests of concrete have also been conducted over a long period of time by the Los Angeles Harbor Engineering Department. Considerable pertinent and valuable information has been obtained from these tests, permitting betterment in design and in drafting new piling specifications (*Engineering News-Record*, May 6, 1926, p. 732).



PILE TREATING PLANT AT LOS ANGELES HARBOR

After a thorough examination of the deteriorated concrete piling in this and other harbors, and an analysis of the proposals submitted for piling to be used in the new terminal facility, Berths 228 D & E, now under construction, it was finally decided to adopt a new type of piling combining both strength and permanence by providing for a dense concrete ensuring a pile of maximum strength and, in addition, to treat the piling under pressure at low temperatures, forcing in sufficient asphalt to penetrate to a depth of approximately 1½ in., thus filling all of the pores in the outer section and eliminating the possibility of sea water entering the pile at all.

The impression has prevailed that the above process is a patented method. It should be definitely stated at this time that this treating process is not patentable. In fact, an application was submitted recently to the United States Patent Office and was denied. It is a method very similar to the creosoted timber pile treatment, which is not patentable.

Impregnating Specification—The different stages of pile manufacture and treatment, as provided in the Los Angeles Harbor Department revised specifications, are:

(1) A concrete mixture of 1:1½:3 is poured into horizontal wooden forms.

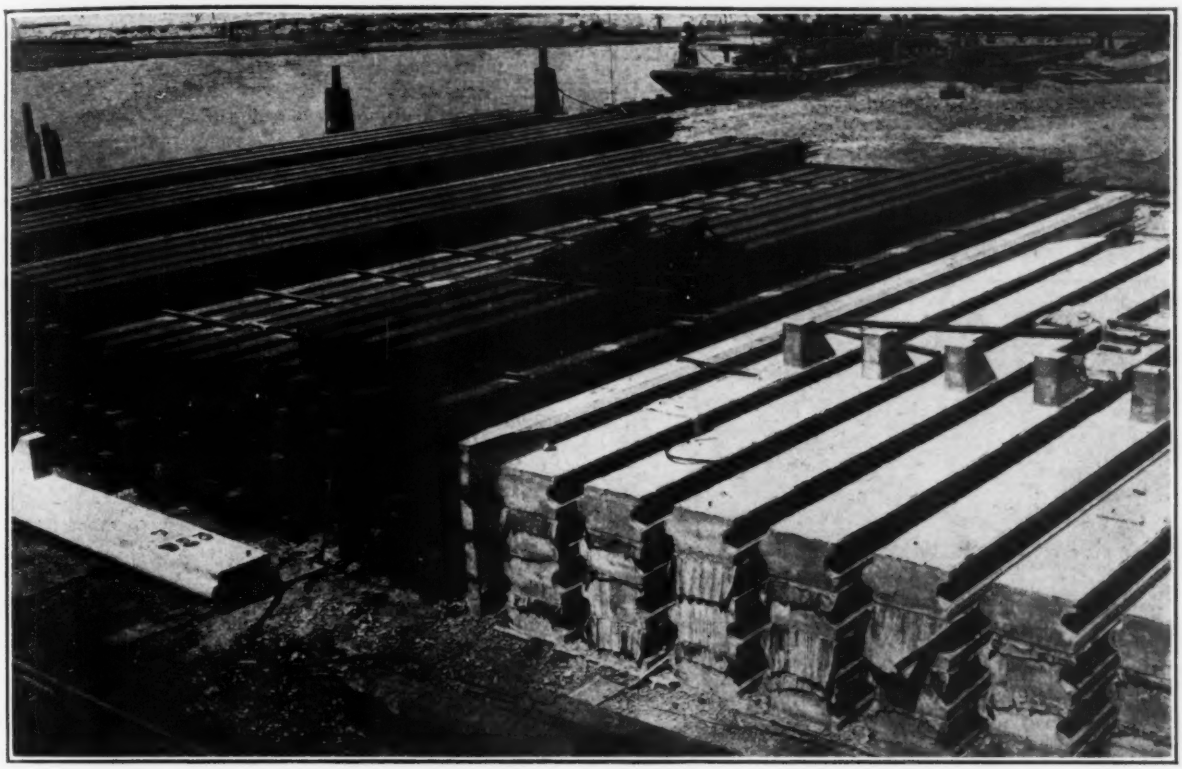
(2) A *slightly* drier mixture is used in the outer 2-in. rim of the pile, from a point 3 ft. below the low water line to the top of the pile. This is accomplished by the use of steel plates, which are lifted during the pouring of the concrete.

(3) Pneumatic hammers are used on sides and top of

forms to produce a vibratory action in the concrete, thus producing a dense mixture.

(4) The tiering of piling under construction is restricted to three tiers.

(5) Concrete piling is cured for a minimum period of 60 days, and on account of progress of treatment some piles are cured for as long a period as 130 days.



UNTREATED CONCRETE PILES IN RIGHT, TREATED PILES IN LEFT

(6) Piles are then placed in an air pre-heater for 12 hours at a temperature ranging from 100 deg. F. to a maximum of 180 deg. F. Free water is driven off in this process.

(7) Piles are removed to asphalt treating chamber.

(8) A 23-in. vacuum is maintained in the treating chamber for two hours.

(9) Asphalt is admitted to the treating chamber at a temperature of 180 deg. F. and increased to a maximum of 250 deg. F.

(10) Pressure of 150 lb. per sq.in. is applied for eight hours.

(11) Asphalt and concrete piling is removed from treating chamber, piling being permitted to cool naturally.

It will be noted that some deviations have been made from previous specifications for asphalt treated concrete piling. A very dense concrete is produced by a rich mixture and the use of pneumatic hammers. Tiering of piling is restricted, and the period of curing has been increased from a minimum of 30 to a minimum of 60 days. The maximum temperature in the pre-heater has been reduced to 180 deg. F. and the asphalt temperature in the treating chamber has been reduced from 500 deg. F. to a maximum of 250 deg. F. Moreover, the piling is finally cooled very gradually.

An analysis of the many official heat tests that have been conducted on concrete and a review of the opinions of the best authorities on this subject disclose the fact that dehydration begins at approximately 500 deg. F. and that until that temperature is reached, the water of combination is not driven off and no injury results. Therefore, our limit of 250 deg. falls well within the limit of safety.

Tests of Piles—Tests of the pressure treated piling now being manufactured show exceptional strength and have surpassed all expectations. This is chiefly due to the rich mixture used, to careful tamping and to the rich mixture used, to careful tamping and to the use of pneumatic hammers, resulting in a very dense concrete. A summary of average and maximum compressive strength for normal and treated concrete specimens tested to date is:

NORMAL CONCRETE

—Average Compressive Strength—		—Maximum Compressive Strength—	
Age, Days	Lb. per Sq.In.	Age, Days	Lb. per Sq.In.
28	4,185	28	5,570
60	5,025	60	6,240
100	5,300	100	7,100

TREATED CONCRETE

—Average Compressive Strength—	—Maximum Compressive Strength—
4,865 lb. per sq.in.	6,070 lb. per sq.in.

NOTE:—Treated specimens vary in age from 60 to 100 days, the average age being 80 days.

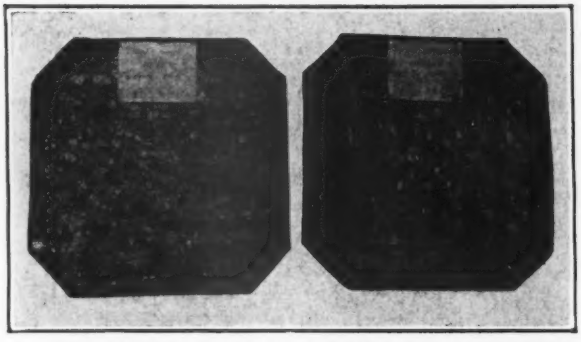
Strength and Durability—The vital objective to be achieved in the manufacture of concrete piling for use in sea water is permanency. Decomposition of concrete between the extreme low water and deck line when exposed to sea water and salt spray over a period of years, results in partial or entire failure. Strength, therefore, is, to a degree, of secondary consideration.

It is the opinion of the writer that entirely too much stress has been placed on the matter of strength in designing and drafting specifications for concrete piling, while too little attention has been given the matter of durability of this same structural element.

Much emphasis has been placed on the fact that

treated concrete, treated for the prevention of deterioration in sea water, has shown in laboratory tests a somewhat lower compressive strength than untreated plain precast concrete piling. However, when the plain precast piling, made both carefully and scientifically, as in the case of some of the best piling in Los Angeles harbor, deteriorates within eleven years to the extent that in some instances one-third of the cross-section is affected, and moreover, when it is realized that it will be a practical impossibility to stop this disintegration, then certainly the matter of durability is of very much more importance than the slightly decreased compressive strength resulting from treatment.

The designed load for concrete piling used in Los Angeles harbor is approximately 30 tons per pile; the actual dead-load being 7 tons and the live-load 23 tons.



CROSS-SECTION OF ASPHALT TREATED PILE BEFORE AND AFTER APPLYING TORCH

A factor of safety of four is used, bringing the ultimate load to approximately 120 tons. As a matter of fact, reinforced-concrete piling as designed and specified by our Engineering Department will sustain a load of probably 150 tons before failure. Considering the actual load of 30 tons, the matter of reduction of a few pounds per square inch in compressive strength is not a vital factor as compared to the permanency of the piling. Recently a load test was conducted at Berth 228 D & E in Los Angeles harbor, and 83 tons was used, all the weight that could possibly be placed on the platform of the test pile made under our recent specifications. This test proved that there was no settlement at the designed load of 30 tons and there was no sign of fracture of the pile under the test load of 83 tons.

Concrete piling should be made as strong as possible, but at the same time sufficient allowance should be made for waterproofing at least the exterior rim of the pile to insure long life and to guard against decomposition. It is contended that plain precast piling, without protection, or even if painted with several coats of the best waterproofing paint, is by far a more expensive pile over a long term of years.

Cost of Installation—In the light of the serious deterioration occurring in untreated precast concrete piling after a few years' service, some terminal engineers have advocated the use of creosoted timber piling.

Considering, however, asphalt treated concrete piling, it can be shown from an analysis of costs and the prospective length of life, that this type of concrete piling under the concrete floor system and transit shed is more economical over a period of years than the creosoted timber piling.

In this connection it may be said that creosoted wooden piling has a life of 15 to 25 years, dependent on the method of treatment and locality of use, or an approximate average life of, say, 20 years.

The initial cost of the asphalt pressure treated concrete piling in place is approximately two-and-one-half times the original cost of the creosoted timber piling installed. The length of life of the concrete piling treated with asphalt to prevent deterioration, we expect to be practically permanent in sea water, but even presuming the very conservative figure of 40 years, or double the life of the creosoted timber piling, the asphalt treated concrete piling is more economical, especially when the following increased costs and disadvantages attending the use of creosoted piling are taken into account:

(1) Replacement of creosoted timber piling at the end of approximately 20 years, at a cost at least equal to the original investment, plus the cost of wrecking and replacement of a large portion of the floor system, to permit the redriving of the piling. If floor system be of reinforced concrete, then the latter increased cost is *very* material.

(2) Increased damage to creosoted piling under shed due to placing and maintaining larger amount of riprap rock on the upper section of slope under facility.

(3) Poor design, due to insecure connection between creosoted wooden piling and concrete beam and deck system, if latter floor system is used.

(4) Non-use of wharf and transit shed for handling cargo during reconstruction period and resultant loss of revenue therefrom.

(5) Increased fire risk of timber construction.

(6) Increased insurance.

The writer concludes after much observation and study of the situation that serious deterioration of concrete piling will be experienced by ports using piling in their terminal structures in sea water unless some form of pressure treatment with a preservative agent is utilized to seal the pores of concrete thus preventing the chemical action on concrete and the oxidation of the reinforcing steel.

Rail Terminals Clog Street Traffic at Chicago

According to a statement made in connection with the traffic survey conducted for the Chicago Association of Commerce, the railway freight terminals are a serious factor in the street traffic congestion. The report states that during one month there were moved over the streets of the central business district nearly 35,000 tons of freight in cartage movements between the numerous terminals. In addition, 8,000 tons were transferred from steamer docks to the railway terminals. While this inter-terminal traffic is important commercially it is disastrous to street traffic conditions because of its comparative slowness of movement. But the most serious effect which the railway terminals have upon street traffic is due to the maintenance of widely separated and independently operated freight houses, resulting daily in thousands of unnecessary cartage movements. Six passenger terminal stations within or adjacent to the central business district serve 23 trunk railways which bring to the district about 29,173 persons on a typical day. An average of 4,000 passengers daily are transported through the district from one station to another by a transfer company which operates 106 motor buses for this purpose. This addition to the street traffic, however, is small as compared with that from the freight terminals.

Long Cantilevers Carry 16 Stories of Tall Building

Roanoke Tower Building in Chicago on Narrow Site—Structure Widened by Cantilevering Upper Floors Over Adjacent Roof—Wind Bracing—Lead Bearing Plates for Columns

CANTILEVERING an extension of the upper sixteen stories of a 37-story building 18 ft. over the roof of an adjacent building, with width of building in the lower 21 stories only 40 ft., is the conspicuous feature of the structural design of the Roanoke Tower now under construction on West Madison St., Chicago. This building, which has 36 of its floors laid out for office purposes, forms an addition to the east side of the 21-story Roanoke Building. Due to lease requirements the addition, however, is structurally independent of the original building and is known as the Roanoke Tower Building. On the east side it is flanked by the 17-story Advertisers' Building. The Madison St. elevation with the cantilever projection and the offsets reducing the size in the upper portion, and typical and special features of the steel structural framing are shown in Fig. 1.

In plan, the Roanoke Tower Building is 40 ft. 2½ in. wide by 87 ft. 1½ in. long out to out in its main portion, with its narrow side fronting on Madison St. At the 22nd floor, the overall width is increased from 40 ft. 2½ in. to 57 ft. 5½ in. by the cantilevered portion. Starting at the 24th floor, both width and length are reduced by offsets in order to comply with the city ordinance regulating the heights of buildings. The total height of the building from sidewalk level is 452 ft. 7¼ in.

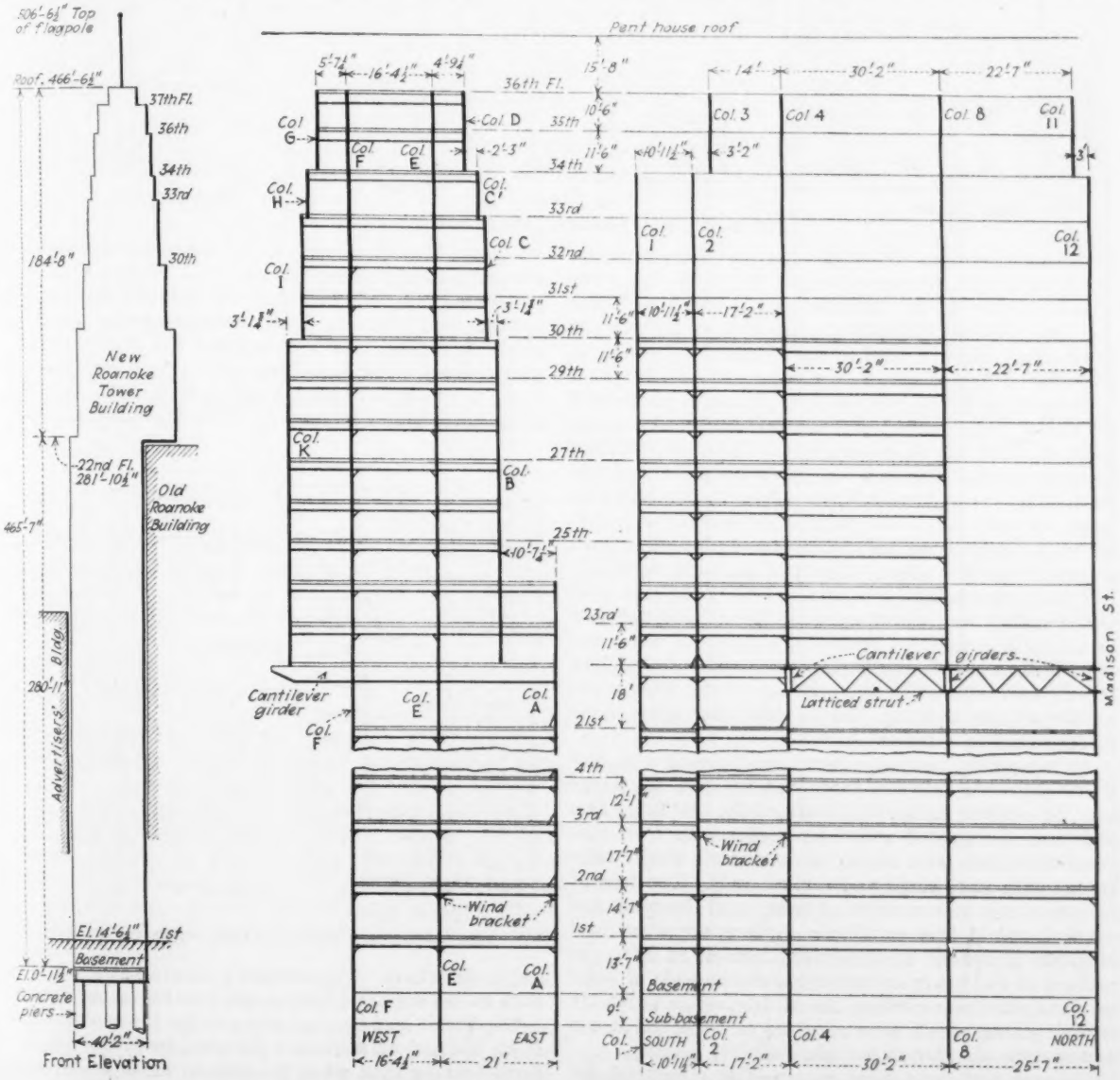


FIG. 1—ROANOKE TOWER BUILDING, CHICAGO
Front elevation and structural design, showing cantilevered floors.

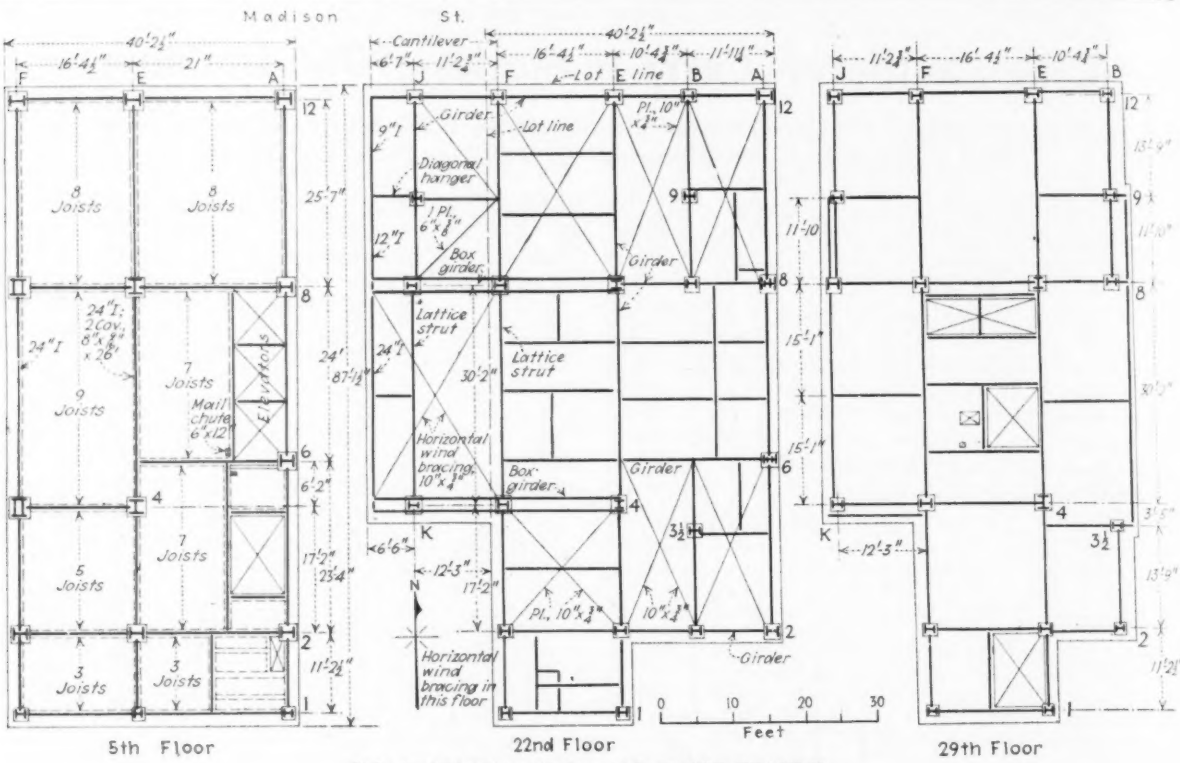


FIG. 2—COLUMN LAYOUT AND FLOOR FRAMING

This compares with 556 ft. for the top of the cross on the spire of the Methodist Temple, 515 ft. 8 in. for the 45-story tower of the Morrison Hotel and 456 ft. for the Tribune Tower Building. All of these figures are taken from sidewalk level to the architectural summits, exclusive of flag poles.

Foundation Piers and Girders—Concrete piers built by the Chicago method of open caissons sunk to bedrock, at about 102 ft. below sidewalk level, support the steel structure. The outer piers on both the east and west sides are kept with their edges at the property lines, so that cantilever foundation girders were required to support the wall columns and place their load concentric on the piers. The two adjacent buildings also have foundations consisting of piers built on bedrock, so that no underpinning of these buildings was required in connection with the sinking of the piers for the Roanoke Tower Building. Since this building is only two bays wide, the columns on the line in the middle of the building had to take the uplift from girders on each side.

At two points, twin piers were used, placed with just 6 in. clearance between them, rather than one large pier, in order to reduce the length of the cantilever arm and thus the size of cantilever girder. In each case these twin piers were capped by a concrete girder reinforced with steel hoops and vertical rods. The tops of all piers are also reinforced with steel hooping and vertical rods. The cantilever girders are structural steel box girders of depth varying from 4½ to 6 ft. On account of the heavy column loads on the ends of some of these cantilever girders, the girder section is mainly in web plates, which were required to be milled at top and bottom in order to provide sufficient bearing.

Columns and Lead Base Plates—The structural design of this tall building is illustrated in Fig. 1. All columns are built-up members and most of them are of the usual H-section. In several cases, however, where an exceptionally heavy section was required, it was considered desirable to divide the web and make a box section (see Fig. 3), thus distributing the metal to better advantage and avoiding the use of long rivets. The heaviest column section, with a load of 5,685,000 lb. on the base, is composed of two webs 16x2½ in.; two 26-in. cover plates totaling 5¼ in. in thickness, and four

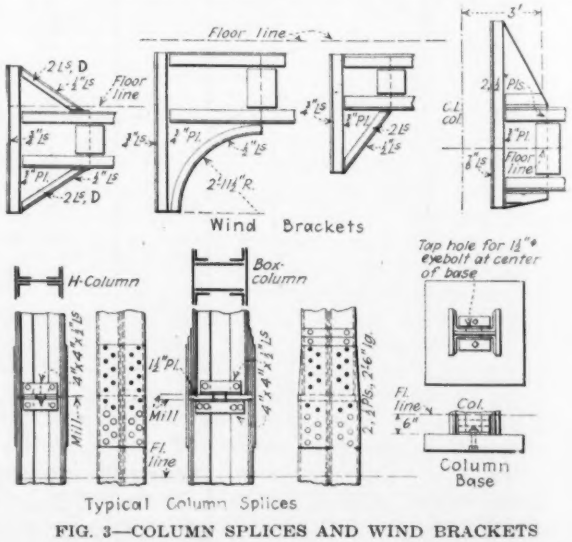


FIG. 3—COLUMN SPLICES AND WIND BRACKETS

angles 8x8x1⅛ in. The columns are in two-story lengths, with milled ends and having splice plates on the flanges.

The use of lead bearing plates under the column bases is an unusual arrangement designed to give more uniform bearing than when the column bases are grouted in place. This practice makes special care necessary in leveling the top of the concrete pier at the proper

elevation for setting the column and requires that the top of the column base be milled exactly parallel to the bottom of the base. The method proved entirely satisfactory in this case.

The column bases, Fig. 3, are round or square slabs of rolled steel 6 to 12 in. thick, with two holes for the column shoe bolts, these holes being countersunk on the underside to receive the heads of the bolts. A lead plate ⅛ in. thick was used under the slab and beneath this

span the short dimension of the panel, which is across the width of the building.

All wind bracing consists of gusset connections of girders and columns. In view of the great height in relation to cross-sectional area of the building, these were required on all interior girders as well as on the spandrel girders. With windows on all sides of the upper portion and with provision for openings in the wall adjacent to the Roanoke Building, there was no

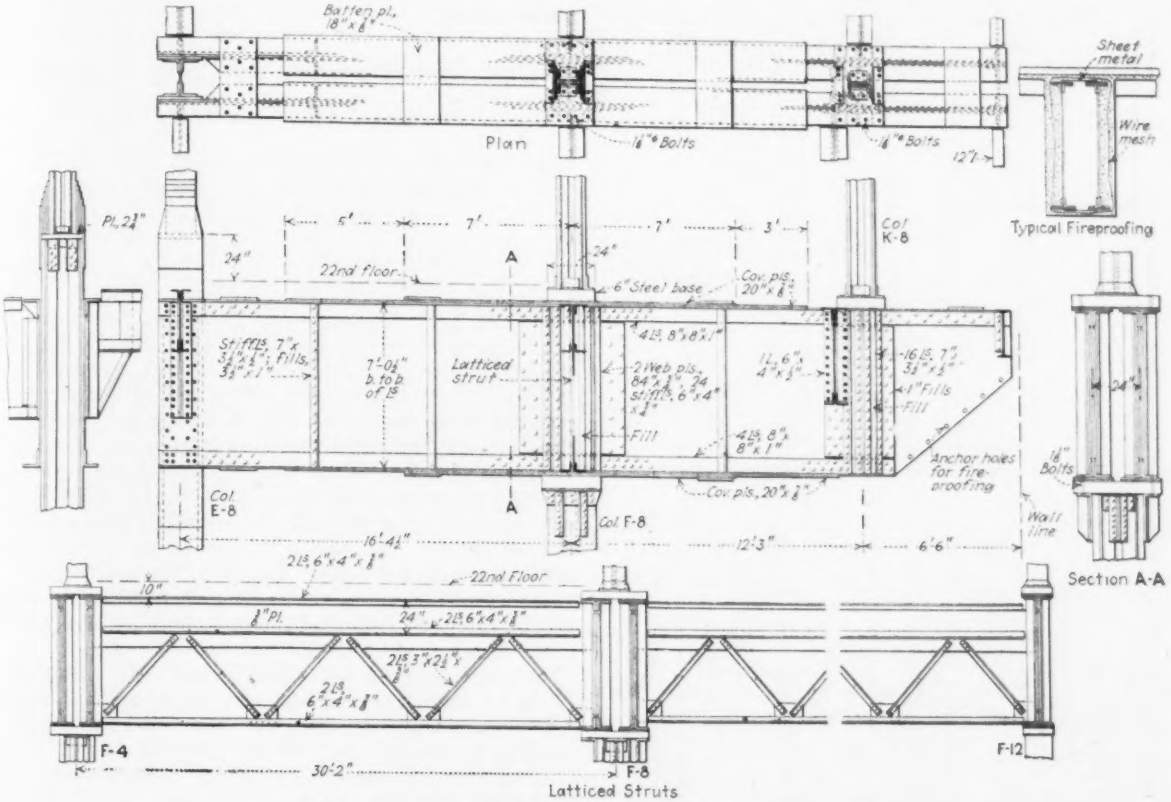


FIG. 4—CANTILEVER GIRDERS FOR 18-FT. PROJECTION

was 2 in. of grout or mortar placed monolithic with the concrete in the pier tops.

In the structural layout, there are fifteen columns in the lower floors, arranged in three rows connected by girders in both directions. Four of these columns extend to the 34th floor, two to the 35th, two to the 36th, two to the 37th, two to the 23d, and two to the 22nd, while one stops at the 6th floor on account of code requirements of set-back on the alley. Additional columns were required in the upper stories and these were supported on girders, framed to the main columns below. Fig. 2 gives typical examples of the structural layout.

Floors and Wind Bracing—Floor framing consists almost entirely of plate girders, few rolled sections being used. This is due to wind bracing requirements, as for this tall, narrow building most of the girders required wind bracket connections. There is no truss work in the building.

The girders running lengthwise of the building support reinforced concrete joists spaced 36 in. c. to c., formed with metal pans 10 in. deep and 30 in. wide, with a top slab 2½ in. thick for the lower floors where wood finish is used and 3 in. thick in the upper stories where cement finish is used. In general, these joists

opportunity to use vertical diagonal bracing. Such bracing might have been introduced in some of the lower panels of the west side, but there it was not considered of sufficient value to be used. Different forms of wind brackets are shown in Fig. 3. Horizontal diagonal bracing consisting mainly of bars 10x¾ in. is introduced in the 22nd floor (see Fig 2).

An elevator shaft is provided for three elevators extending up to the 21st floor, where a crossover is arranged and two other elevators are provided running from the 21st to the 35th floor.

Cantilevered Extension—At the 22nd floor, the west side of the Roanoke Tower is extended about 18 ft. over the roof of the adjacent Roanoke Building as shown in Fig. 1. For this purpose, two double-web plate girders and one single-web girder, all 84½ in. deep and 35 ft. long, are used as cantilevers, seated on the columns along the west property line. As shown by Fig. 4, the tops of these girders are just below the 22nd floor and their ends project approximately 18 ft. beyond the west wall columns. Upon these girders are seated the columns for the upper stories of the main part of the tower and the cantilevered projection. Lattice struts are framed between these girders and horizontal

diagonal bracing is introduced in the floor framing of the 22nd floor. This floor also has a solid concrete slab 6 in. thick instead of the slab and joist construction used elsewhere.

It will be noted by Figs. 4 and 5 that the outer supporting columns in this cantilever projection are not on the ends of the 18-ft. cantilevers, but are only about 12 ft. beyond the wall column of the lower tower portion, while the framing for the outer 6 ft. of the projection is by means of diagonal hangers and struts in the several stories. This outer 6 ft. is cut off above the 27th floor, due to an offset in the building, so by setting the columns in 6 ft. from the ends of the girders these columns could be continued up to the 30th floor and the load of overhang delivered to the cantilever girders closer to the point of reaction. This meant a very material reduction in the required size of the cantilever girders.

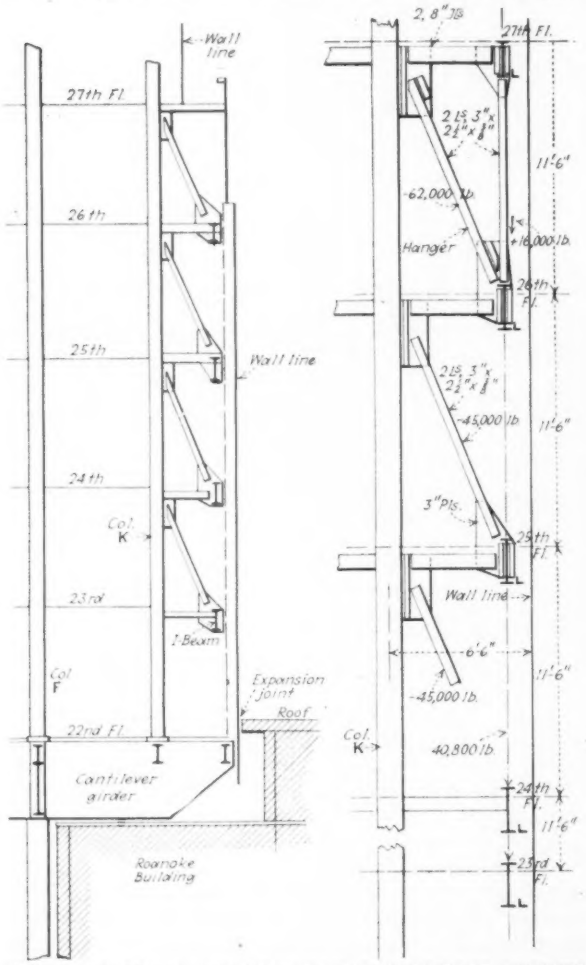


FIG. 5—DIAGONAL FRAMING IN CANTILEVERED STORIES

Provision was made for temperature changes and compression in the Tower Building columns next to the Roanoke Building by allowing a vertical joint in the masonry in front and rear walls between the old and new buildings from the basement to the underside of the cantilever girders at the 22nd floor. A horizontal joint in the masonry of both these walls was also made immediately below the cantilever girders, to take care of the deflection of these girders as well as the changes due to temperature and column compression.

Designers and Builders—The architects for the Roanoke Tower were Holabird & Roche, with Rebori, Wentworth, Dewey & McCormick, Inc., associated. The structural design was prepared by the structural department of Holabird & Roche, with W. B. Gray in charge of the design under the direction of F. E. Brown, chief structural engineer, and H. J. Burt, consulting engineer. The Dahl-Stedman Co. has the general contract, and the American Bridge Co. furnished the structural steel.

Comfort Stations in Cook County Forest Preserve District

Digestion Vault with Water from Station Roof and Air Furnished to Colloiders by Windmill-Driven Pump

By George Elliot Perry
Chicago, Illinois

TO SERVE the large crowds which frequent the 27,000 acres of the Forest Preserve District of Cook County, which includes Chicago (users estimated at 7,500,000 persons annually), about 250 public comfort stations have been installed, including fifty isolated five-unit non-flushing water closets designed after the Perry method. This system, which depends upon aerobic bacterial action for sanitary disposal of the sewage, was selected mainly on account of the small amount of attention needed, the vaults having to be cleaned out only about once a year. The fifty stations were installed in 1922, at a cost of about $1,500 for each station complete, including the tank, building and windmill. Fig. 1 shows a station and its windmill.

The buildings are hexagonal in plan (Fig. 2) about 12 ft. in diameter, each erected directly above a vault 6 ft. square and 8 ft. deep. At one side of this main vault is a smaller vault which provides for treating such overflow as may be caused by displacement. In each vault is a stack of Perry colloiders which supply air at about 3 lb. pressure, delivered intermittently to the bottom colloider of each stack by means of an air pump operated by a windmill. With the five seats arranged directly over the vault there is no need of flushing, and as all solids are at once surrounded by aerobic or fully oxygenated water there is no odor, except for a short period immediately after occasional excessive overloading. The sixth compartment has a water tank for janitor's service.

Studies indicated a probable total load of 5,000 defecations for each station during the season and the vaults were made of such size as to care for several times that number. On many holidays, however, they are used to a much greater extent than that for which they were designed; in fact, the foresters have stated that at times some of the buildings have been in continuous use for two or three hours. In prolonged droughts the water level has been lowered occasionally below what was expected, the only water supply being the rainwater runoff from the roof. Some of the stations at the more frequented points have required two cleanings in a year, but the others have been pumped out only once, either in the fall or spring. A gasoline pump with a long line of discharge hose delivers the sludge or vault contents to the Des Plaines River or other stream during flood or high water. During the winter, the

stations are closed and the windmills are furled and sealed.

The colloiders used in this case are stacks of circular cast-iron saucer shaped units, placed in inverted position and having interior baffles or partitions which direct the flow of air from unit to unit and also trap or retain air within the hollow space whenever the flow of air ceases. Air delivered at the bottom traverses each unit in turn, following a spiral path and escaping to the atmosphere from the top unit. It is the oxygen dissolved from the large areas of air surfaces presented

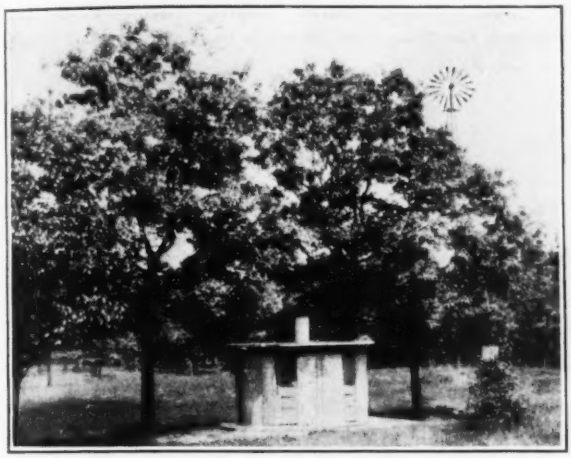


FIG. 1—PUBLIC COMFORT STATION IN COOK COUNTY FOREST PRESERVE NEAR CHICAGO

Windmill drives pump supplying air to digestion vault which receives rain water from roof of station building. Fifty of these stations have been in use since 1922.

to the liquid in the vault that maintains aerobic conditions.

A modified design based upon experience with the fifty stations noted above, provides against drought or holiday overloads by increasing the vault capacity to 250 cu.ft. per seat instead of 50 cu.ft. In such case, cleaning should be required only once in two years or more. With the present colloiders, such large quantities of rags, waxed paper, newspaper and cardboard boxes were thrown into the vaults that the 3x3-in. excess-air delivery or uptake holes were in danger of clogging and thus cutting off the air from the colloiders above the clogged holes. A new type of non-clogging colloider, planned for the modified design, consists of concrete units 4 ft. long laid against the wall and having their air chambers so connected that one air pipe is sufficient to serve a stack 12 ft. long. There is also a sump, so that any sludge left by the pump can be flushed to the sump and removed by a bucket and rope from the top. In the Cook County toilets, no sump was provided, and as the foot-valve strainer was 4 in. high, the pump left about 12 cu.ft. of sludge in the vault. The central ventilating stack is omitted as unnecessary, there being no objectionable odor from the present vaults. The water tank is also omitted.

The sludge being well circulated and digested under aerobic conditions, is so inoffensive that it may be used as a fall dressing for lawns or gardens. The effluent is odorless and has sufficient dissolved oxygen to preclude its causing a nuisance, as is evidenced by an early installation at a golf club where the total effluent flows through an open seepage ditch about 10 in. wide and 100 ft. long, parallel with and between two of the

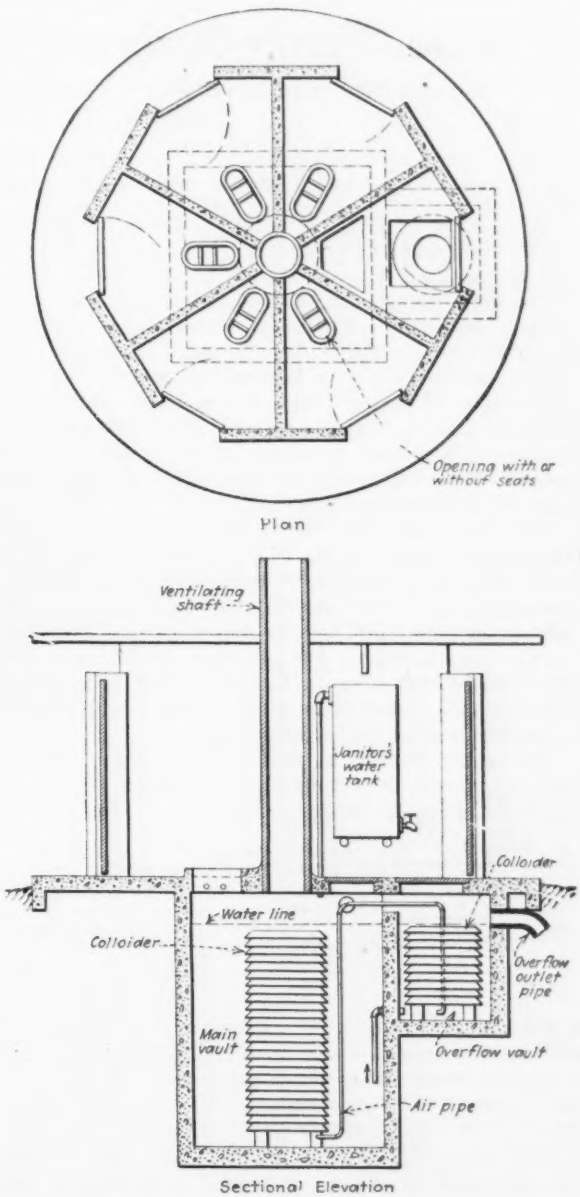


FIG. 2—DETAILS OF DIGESTION VAULT, COOK COUNTY FOREST PRESERVE COMFORT STATION

Overflow pipe from final tank has light joints until it reaches a seepage trench, then has open joints.

fairways. A feature of no little importance lies in the fact that the colloiders require so little air as to permit the use of water-jet air-compressors with jets as small as $\frac{1}{4}$ in. in diameter. Thus no electric wiring or apparatus need be installed, as city water pressure will give an ample supply of air at small initial and running expense. This system is specially adapted to warm climates, as the bacteria act most effectively with the vault liquid at temperatures of 80 to 90 deg. F. A film of oil on the liquid would prevent trouble from flies or mosquitoes. The system has been patented in the United States and foreign countries by the writer.

The Cook County stations were built under the direction of E. J. Flavin, chief engineer of the Forest Preserve District of Cook County.

Water-Intake Designed for Wide Distribution of Flow

Johnson-Wahlman Draft Distributor Draws from Wide Area Without Unduly Affecting the Flow—Typical Installation in Canada

By Milton G. Salzman
With R. D. Johnson, Hydraulic Engineer, New York

A COMPARATIVELY recent and novel innovation in the field of water-power engineering is the invention of the "draft-distributor" type of intake. As its name implies its principal object is to draw water from a large area of river or reservoir into the comparatively narrow section of a pressure conduit or open canal without unduly disturbing the natural flow conditions and with a minimum of loss which would otherwise be caused by an uneven distribution of draft. Under certain very common conditions this style of intake offers many distinct advantages over the usual type of waterway entrance structure.

The important feature of this type of intake is a submerged conduit *A-B*, Fig. 1, called a "gathering tube" having a constant or diminishing area towards the outer end *A*. The tube may either discharge directly into a pressure conduit *D*, as shown, or into a receiver such as a canal with a low velocity. In the latter case the cross-section area at the inner end is gradually enlarged in a funnel shape so as to form a diffuser for regaining most of the velocity head.

The water is made to flow from the river into the tube by means of a forced loss of head or drop in hydraulic gradient between the river surface and the

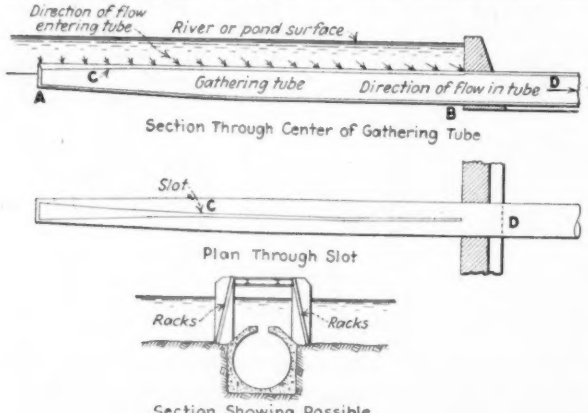


FIG. 1—TYPICAL DRAFT-DISTRIBUTOR INTAKE

pressure level in the conduit or canal surface, through a tapering slot *C* having widths varying with the gradient drop.

The draft-distributor may be employed either with or without the use of trash racks.

By means of a rigid mathematical theory the slot and tube may be properly dimensioned so as to draw an equal quantity of water from each linear foot measured along the slot, or, if for any special reason it is necessary to vary the intensity of draft, any such predetermined variation can be accomplished by proper design.

The stability or assurance of a distribution of flow as desired is more or less proportional to the total loss of head which is permitted. Experience thus far has demonstrated that a total loss of head amounting to one-fifth of the velocity head measured at *D* is ample to secure reliable results and there is no present indication that the loss may not be further reduced without detriment to the design. This, obviously, is less entrance loss than that found in the usual type of intake

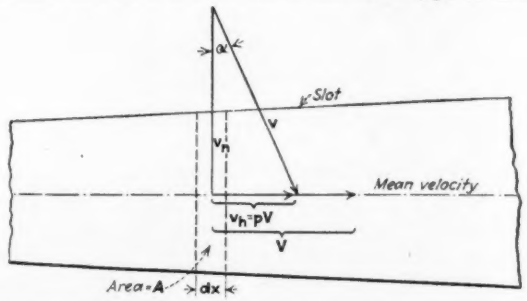


FIG. 2—FACTORS AFFECTING FLOW THROUGH THE SLOT

and, consequently, materially reduces the cost of lost power consumed in the entire plant.

The other principal inherent advantages of the draft-distributor may be enumerated as follows:

(1) It provides an intake giving absolute control of the distribution of the water at all times by means of an accurate distribution of draft from the source of supply.

(2) With the conventional type of intake using a wide flaring mouthpiece it is practically impossible to control the uniformity of flow through the trash racks. At full loads high local velocities are formed and in some regions the resulting turbulence may actually cause the water to flow backwards through the racks. This, naturally, results in high concentrated velocities at certain sections of the racks and a condition where they are being continually blocked with débris, causing still higher velocities and possible progressive stoppage of flow and the shutdown of the plant. This means constant attendance and resultant high operating cost. With the distributor type of intake, ample area enables the velocities through the racks to be low and evenly distributed at all times.

(3) The straight projecting gathering tube provides a very convenient method for utilizing two sets of trash racks, one on each side of the tube, connected by an overhead platform upon which may be run a traveling crane for the removal of the racks. This possible arrangement is illustrated in Fig. 1.

(4) By means of several parallel gathering tubes it is possible to draw water from large rectangular areas of shallow lakes or rivers with a minimum disturbance of the natural conditions of flow.

(5) If the river carries ice or other floating material such as logs, the entrance velocity of the water near the slot can be made less than the buoyancy impulse of the floating material and thereby permit the floating matter to continue undisturbed its natural course down the river.

(6) For the purpose of removing sand or silt from a forebay or sandtrap a series of distributors can be used to advantage. In order to draw the silt from the farthest point with the same effectiveness as from the point nearest the inside end, it is necessary that the draft velocity of the silt-removing water be the same at both ends. This can be accomplished by means of a correctly designed gathering tube. The axial velocity of the water inside the distributor can be kept sufficiently high to prevent any sand or silt settling within.

(7) The uniformity and moderation of velocity in the draft-distributor prevents scouring of the river bed in the immediate vicinity of the intake, as is sometimes the case with the more conventional open types.

(8) Where the geological structure of the river bed is such that considerable excavation below the elevation of the natural river bottom is impracticable, as in the case of a sandy bottom or boulder bed, the draft-distributor lends itself to the particular advantage of construction without materially disturbing the contours of the river bottom.

(9) Where the draft distributor type is employed there is also a minimum cost of unwatering during the construction period as it does not require deep excavation with the necessary use of heavy cofferdams.

(10) The draft-distributor type does not involve any heavy water or static loads. Consequently it lends itself particularly to economical construction.

(11) This type of intake is easily adaptable to a plant extension at a minimum cost.

Design Theory—The theory of design of the draft-distributor is based upon a rational mathematical analysis. The correctness of the theory has been amply confirmed by tests on existing structures as well as by means of experimental models. The results of these tests furnish assurance that the designs will function as intended with a precision greater than necessary for practical results.

It is not the purpose of this article to set forth the theory in detail but merely to indicate the general procedure of design in order to bring out more clearly the principles involved.

The general shape, length and cross-sectional dimensions of the gathering tube are determined by such considerations as economy of construction, the degree and distribution of draft required, and the necessity of maintaining everywhere a velocity consistent with the conditions upon which the design is based.

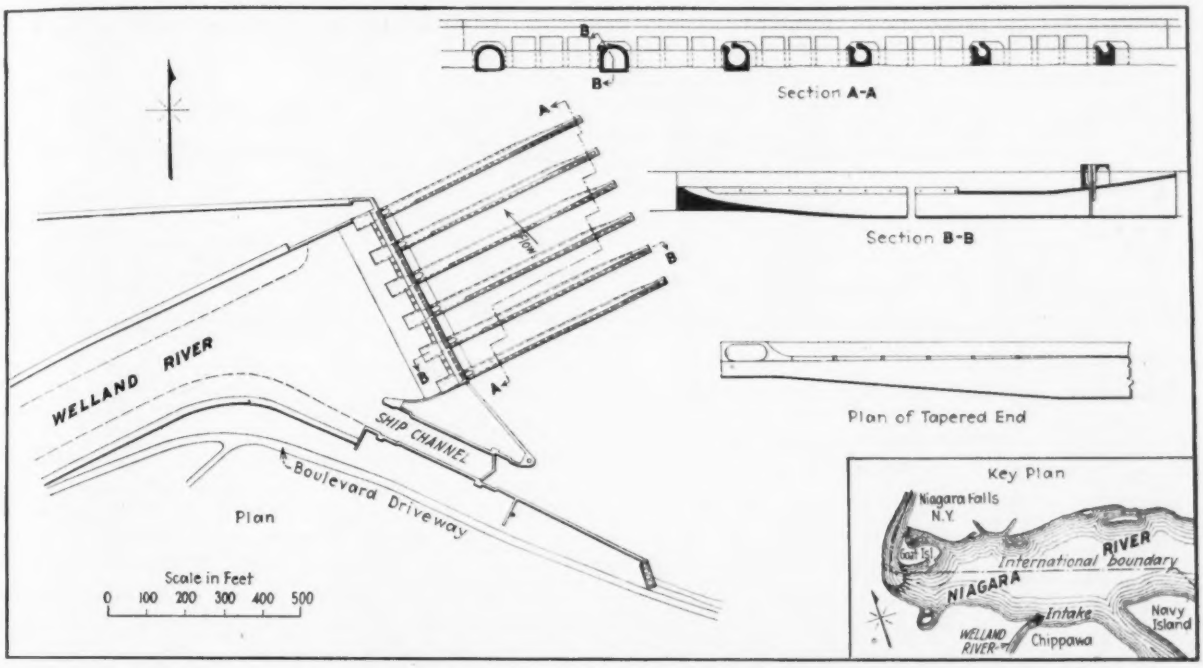


FIG. 3—GENERAL ARRANGEMENT OF INTAKE DESIGNED FOR QUEENSTON-CHIPPAWA PLANT

The water is made to enter the slot and assume an axial flow only by virtue of losses of head accumulating to a certain magnitude between the outer surface of water and the entrance to the conduit proper. This head loss is made up of three separate components: (1) An assumed loss h_o called the "primary loss" at the beginning of the tube. (2) A cumulative loss Δh_i called the "induced loss" caused by the impact of the water flowing through the slot upon the water flowing axially through the bore of the tube itself. (3) The ordinary friction loss h_f in the tube.

The "primary loss" is fixed by trial at a definite value and constitutes the initial impulse necessary to make the slot begin to function. The element of judgment resulting from a certain amount of experience is very essential in fixing this at a practical value commensurate with good design, since its magnitude influences the total entry loss of the plant.

The friction loss in the tube is usually a small percentage of the total and is determined by the physical characteristics of the tube. The so-called "induced losses" are based upon a theory which takes cognizance of the fact that by proper design of the slot, as explained later, the water is drawn through at definite angles with the center-line of the tube. Fig. 2 shows a

vector diagram of the velocities involved in a segment of a gathering tube of varying cross-section.

Taking a differential increment of length dx the water enters the tube through the slot at an angle α with the normal and at a certain velocity v at the control or inner section of the slot. If, then, the horizontal component v_h of the entering velocity is less than the existing velocity V flowing axially in the tube (assuming uniform velocity throughout the cross-sectional area A) and equal to pV, where p is the ratio of v_h to V, certain losses of head must accumulate due to speeding up the velocity of the entering particles of water to that existing within the tube. Denoting the change in velocity by Δv, we have

$$\Delta v = V - pV = V(1 - p)$$

If even distribution of draft is desired throughout the length L of the tube, the quantity q entering per unit of length of pipe (or slot) may be determined by

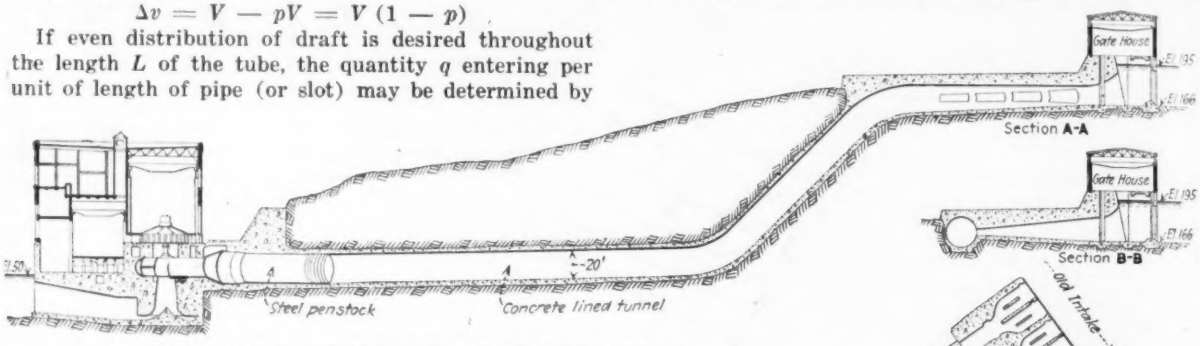


FIG. 4—DRAFT-DISTRIBUTOR INTAKE AT SHAWINIGAN FALLS

dividing the maximum total desired quantity $Q_{max.}$ by the overall length of the tube, or

$$q = \frac{Q_{max.}}{L} = \text{sec.-ft. per running foot.}$$

This quantity q produces an increment to the quantity Q already flowing through the portion dx under consideration in the following relation

$$dQ = q\,dx$$

The accumulated "induced losses" Δh_i may be expressed in the form of a differential equation through an axiomatic statement based upon Newton's Second Law of Motion that "the increment of mass per second multiplied by its change in velocity is equal to the corresponding loss of force, or head." This may be stated algebraically as follows:

$$A\,dh_i = \frac{dQ}{g} V(1 - p)$$

and, inasmuch as $A = \frac{Q}{V}$

$$dh_i = V^2(1 - p)\frac{dQ}{Q}$$

This represents the fundamental equation for induced losses and completely expresses all the essential features of the theory so far as it has been developed to date.

It may be integrated quite easily and thus gives rise to four possible considerations, viz.:

(1) Allowing V to vary as any convenient function of Q, say, as Q^m, and, at the same time, $(1 - p)$ is made to vary as, say, Q^n.

(2) Making V constant and $(1 - p)$ varying as Q^n.

(3) Making p constant and V varying as Q^m.

(4) Making both V and p constant.

The coefficient n may conveniently be made unity in some cases and m may also be made unity. The latter expresses the relation when there is a constant area of pipe, or V varying directly as Q.

The equation is independent of the distance x from the initial starting point or outer end, and time t except as these factors may become definite when the variation in A is fixed with respect to Q in an actual design. Likewise, it will be observed, the variations of Q do not enter directly into the equation.

One of the obvious features of this theory lies in the fact that the flexibility obtained by means of the fundamental equation leads to an almost unlimited number of solutions for any desired condition. Hence, the element of judgment obtained by a certain amount of experience with previous designs is very essential to fix and coordinate properly the variables involved.

The total loss of head h_s at any point relative to the river level (assumed constant) is equal to the sum of the component losses at that point, or

$$h_s = h_o + \Delta h_i + h_f$$

The velocity of the entering jet of water at any point is equal to a certain coefficient of entry C times the spouting velocity at that point.

Therefore, the velocity entering the tube may be expressed as follows:

$$v = C\sqrt{2g\left(h_s + \frac{V^2}{2g}\right)}$$

The theoretic width of slot, called W, is equal to the rate of inflow per running foot of slot, or

$$W = \frac{q}{V_h} = \frac{q}{\sqrt{v^2 - p^2V^2}}$$

Therefore,

$$W = \frac{q}{\sqrt{C^2(2gh_s + V^2) - p^2V^2}}$$

from which W may be determined for any value of q, V and p.

The maximum value of W at the extreme end of the tube is fixed by the limiting possibilities of an actual design, such, for example, as the width of the slot becoming greater than the diameter of the pipe, or, even, a surd, incapable of evaluation. These limitations are disclosed when the algebraic terms are translated into numerical quantities.

In order more easily to visualize the above theory it may be conceived that where uniform distribution of draft is desired, if the total drop of head is very large, due to the assumption of a high primary loss, the

induced loss and friction loss will be relatively insignificant. There is, then, the condition of a simple rectangular submerged orifice, or, in other words, a slot of equal width throughout to draw in the water evenly.

FIG. 5 (ABOVE) — EXTERIOR AND INTERIOR VIEW OF INTAKE AT TEMISKAMING, QUE.

If, therefore, one considers a differential increment of length where the drop in head at any point is just right for the width of slot, the water will enter the tube in a perpendicular direction. As the loss of head is made smaller, as it must be in a practical case, the water must, necessarily, enter at an angle in order to obtain the requisite equivalent width of slot.

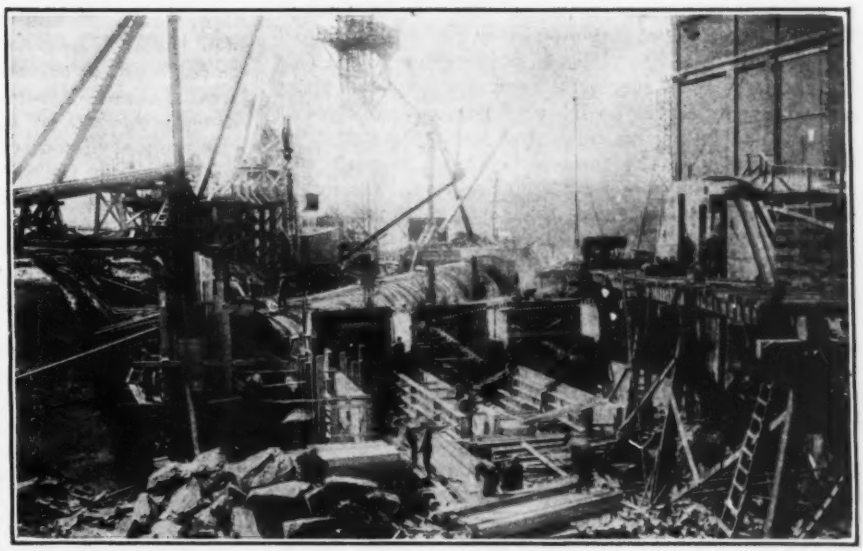
The usual procedure of design is to adopt a value of primary loss which is just right for a suitable assumed width of slot at the beginning of the tube. As the drop due to the friction and induced losses is not effective at this point, the water will enter the tube perpendicularly. As we go along the tube, however, the value of these two losses becomes more effective and the increasing head causes the slot gradually to become narrower and the water to enter, usually, at slightly different angles dependent upon the adopted value of the horizontal component of the entering velocity to the actual velocity obtaining in the tube. The latter value calls for the exercise of considerable judgment on the part of the designer. Practically, the water will enter the slot vertically at all points and gradually curve around until it acquires the theoretical angle at the point of contact with the water flowing in the tube.

The value of the coefficient of entry C through the slot is again a matter of judgment coupled with knowledge derived from previous experience and tests. By proper design of the fillet forming this entrance, the coefficient may be made quite high, thereby reducing the total loss of head to some extent.

It has been conclusively proved that a small reasonable error in the value of the unknown coefficients will not have any appreciable practical effect upon the distribution of draft.

Another factor of some magnitude which must be taken into consideration is the fact that the theory is based upon an equal distribution of draft at the control section or inner side of the gathering tube, where the entering water begins to merge with the main body flowing in the tube. Evenness of distribution, however, is desired on the outside of the gathering tube,

FIG. 6 (BELOW)—CONSTRUCTING DISTRIBUTOR INTAKE AT SHAWINIGAN FALLS



and, consequently, a correction factor must be introduced to take account of the variation in the draft caused by the depth of the slot.

In some cases, where cantilever action throughout is structurally undesirable, the tube adjacent to the slot may be supported either by built-in "fish-shaped" vanes or cast-iron separators spaced at definite intervals along the tube. To realize perfect distribution an allowance adjacent to each separator, in the width of the slot should, in such cases, be made for the area occupied by these details (see Fig. 5).

A very interesting feature of the theory is the fact that the evenness of the distribution is not to any material extent, within reasonable limits, a function of the quantity of water drawn through the intake, so that once right for a particular draft of water it will remain so, substantially, for other quantities drawn. The slot should, however, be designed for the maximum draft

which is expected in order that the best conditions may prevail when most needed.

Fig. 3 illustrates a practical application of the draft-distributor type of intake in a river where floating ice may be a source of trouble. This was designed for the Queenston-Chippawa power canal of the Ontario Hydro-Electric Power Commission development at Niagara Falls for a normal flow of 15,000 sec.-ft.

The whole intake is actually a combination of a submerged draft-distributor intake to take care of the flow during the ice season and the conventional surface intake to supplement it during the normal periods. By using six parallel gathering tubes a greater river surface area is covered than with only one and it is possible to draw in water without disturbing the course of the floating ice or débris. Before discharging into the canal entrance the tubes are gradually enlarged as diffusers in order to regain most of the velocity head.

The Ontario commission carried on an extended series of tests and experiments on large scale models of several types of intakes in order to find the design most adaptable to their needs. The draft-distributor type was finally selected as promising the best security against possible aggravated ice conditions in the Niagara River but the tubes have not yet been built.

Fig. 4 also shows a distributor intake designed for a hydro-electric plant at Shawinigan Falls, Quebec, Canada, under the supervision of S. Svenningsen, chief engineer at the Shawinigan Engineering Co. This intake has been in successful operation for some years and admirably serves its intended purpose. It consists of only one gathering tube, drawing the water from five sluiceways in the forebay bulkhead, through corresponding passages of rectangular section. The intake is designed for a normal discharge of 2,940 sec.-ft. A model of this intake was built and tested satisfactorily.

Another draft-distributor has recently been constructed for the Riordan Pulp Corporation at Temiskaming, Quebec, under the supervision of H. G. Acres & Co., Ltd., Niagara Falls, Canada, for a normal flow of 2,500 sec.-ft. as an addition to an existing plant. Fig. 5 illustrates an interior and an exterior view of this intake previous to the admittance of water.

Designs are also now under way for the proposed 80,000-hp. development of the International Paper Co. at Grand Falls, New Brunswick. In the United States, the Washington Water Power Co. of Spokane, Wash., has recently ordered a distributor intake of 2,000 sec.-ft. immediate capacity and 5,000 sec.-ft. ultimate capacity for its new development at Lake Chelan.

The Johnson-Wahlman draft distributor was invented by Petrus Wahlman, now deceased, and Raymond D. Johnson. It is covered by United States and Canadian patents with the exclusive license rights vested in R. D. Johnson of New York.

Chimney Damage in Cuban Hurricane

Chimney damage in the Cuban hurricane of Oct. 20 is reported by N. M. Stineman, of the Portland Cement Association, after full study of the hurricane damage as follows: Reinforced-concrete chimneys in 27 cases out of 28 were uninjured, while nearly every chimney made of brick or steel was completely wrecked or seriously injured. One concrete chimney broke in half during the storm, but evidence clearly shows that it was of insufficient section, under-reinforced and poorly built.

Army Engineers Oppose Great Lakes-to-Hudson Canal

Favor Construction of an Enlarged St. Lawrence Waterway Over a New Canal Across New York State

THE adverse report upon the Great Lakes-to-Hudson Canal which was submitted recently to the Committee on Rivers and Harbors of the House of Representatives by the Chief of Engineers and reported upon briefly in our news pages of last week, was the result of a request from that committee to the Chief of Engineers that the Board of Engineers for Rivers and Harbors extend the scope of the earlier investigation of the proposed canal across New York State to consider evidence submitted by the proponents and to add estimates of a canal depth of 30 ft. The earlier report gave consideration to a waterway for vessels of 20 and 25-ft. drafts. It also was an adverse report (*Engineering News-Record*, May 6, 1926, p. 721). Since the publication of the earlier report on the Great Lakes-to-Hudson Canal, the report of the joint board of engineers on the St. Lawrence waterway has been published and the Chief of Engineers states in the present report to the Committee on Rivers and Harbors that the Board of Engineers for Rivers and Harbors, after having considered both the St. Lawrence report and the report of the special board of engineers on the 30-ft. channel for the Great Lakes-to-Hudson waterway, concludes that the economic benefits of this canal are not commensurate with the cost of constructing it, that the expenditure of public funds on the St. Lawrence route would bring the greater economic returns per dollar spent. To this the Chief of Engineers adds:

"The route from the Great Lakes to the Hudson River is feasible from an engineering point of view, and its construction by the United States government would probably be justified in the near future, if the plans for the improvement of the St. Lawrence do not meet the joint approval of the legislative branches and executive heads of the two governments. The cost for navigation alone of the St. Lawrence waterway from the Great Lakes to the ocean for vessels of 25-ft. draft is estimated at $173,520,000, to be borne mutually by Canada and the United States, as compared with $506,000,000 for the Great Lakes-Hudson River route, and the former will afford better relief for the Middle West and is a better investment for the United States as a navigation proposition if mutually satisfactory arrangements for its construction can be consummated."

The additional evidence which the special board of engineers was asked to consider consisted chiefly in studies of potential tonnage made by the Department of Commerce, and a commodity survey of the Great Lakes area by the firm of Fay, Spofford & Thorndike, consulting engineers. After considering these figures, the board was still of the opinion that its original estimate of 13,450,000 tons of traffic for the proposed 20-ft. canal and 15,500,000 tons for the 25-ft. canal are optimistic and probably could not be attained for a considerable period of years after the opening of the canal.

A 30-Ft. Waterway—In estimating the cost of a 30-ft. waterway for vessels of 28-ft. draft, the methods and unit cost used in the preparation of the estimates for the canal for vessels of 20 and 25-ft. draft were used.

In this connection, the board points out that a 30-ft. channel from Oswego to the Hudson River would be valueless without a corresponding deepening of the Hudson River channel between Albany and Ossining, the new Welland Canal, the connecting channels of the Great Lakes, and the primary harbors of the Great Lakes. The detailed estimates of cost are:

		30-ft. channel
Prism excavation, cu.yd.		
257,100,000 earth, dry,	$0.65	$167,000,000
108,200,000, earth, wet	0.35	38,000,000
24,700,000, rock, dry	2.00	49,000,000
5,500,000, rock, wet	5.00	28,000,000
12,900,000, shale	1.50	19,000,000
27,100,000, hardpan	1.00	27,000,000
Locks and operating machinery		81,000,000
Bridges		12,000,000
Dams		6,000,000
Walls, dikes, paving, etc.		79,000,000
Railroad and highway relocation, rights, etc.		5,000,000
Real estate		33,000,000
Total		$544,000,000

The cost of further deepening of the Hudson River to provide a 30-ft. channel is placed at $7,000,000. The existing project calls for a depth of 27 ft. The cost of deepening the Welland Canal is placed at $4,000,000 and of deepening the connecting channels of the Great Lakes at $86,000,000. The latter is stated to be an approximate estimate. The cost of improving and deepening the 27 primary harbors of the Great Lakes along the lines of existing United States government projects is estimated to be $72,000,000.

In regard to the proposition to construct an American canal from Lake Erie to Lake Ontario, the board states that it adheres to its former opinion in regard to the La Salle-Lewiston and the Tonawanda-Olcott ship canals, that the construction of either of these canals in order to provide a canal parallel to the Welland Canal in the United States cannot be justified upon either economic or military grounds. Nevertheless, in order that the desirability of such a canal may be intelligently considered, the board includes an estimate based upon unit prices similar to those used in the estimate for the Great Lakes-Hudson Canal, which gives the cost of the La Salle-Lewiston Canal at $171,000,000 and for the Tonawanda-Olcott Canal, $188,020,000.

In commenting upon the possible advantages of the 30-ft. waterway over one for vessels of 25-ft. draft the board states that many ocean freighters are of drafts between 20 and 25 ft., but that few are between 25 and 28 ft. and that the present lake fleet cannot safely load to drafts greater than 24 ft.; also that there is no immediate prospect of lake channels and harbors being deepened to accommodate ships of 28-ft. draft. Consequently, the board finds no basis upon which estimates of the advantages of a 30-ft. waterway may be founded.

Inadequacy of the Railroads—At a public hearing held by the board, the view was advanced that within 25 years the railroads will be unable to handle the country's normal freight traffic, and it was implied that the construction of the waterway is necessary to relieve the railroads of this prospective burden, regardless of what the cost of construction or the total savings in freight might be. Basing its estimates of progress upon the progress of the railroads in the past, the board finds that if the present rate of increase of the aggregate freight-car capacity is continued until 1950 and if the increase in yard tracks and sidings which has occurred since 1913 is continued, there will be no deficiency in either at the end of 25 years. The board states that it was not found possible to estimate the increase in main line tracks that would be required to handle the increased traffic, but that it was advised by the presidents of the seven trunk line railroads in the northeastern region that the main line capacity of the railroads has not been reached and that it can be expanded almost indefinitely. In this connection, it was pointed out that the construction of a ship canal would not obviate the necessity of increasing railroad facilities, as the canal would be closed to navigation from December to April, at which time the burden on the railroads is heaviest because of weather conditions. If sufficient railroad facilities are provided to handle the winter traffic, they would be able to handle that of the warmer months without assistance from a waterway.

Comparison of Routes—The cost of improving the St. Lawrence route for navigation only with a channel depth adequate for vessels of 25-ft. draft was placed by the joint board of engineers at $173,520,000, while the cost of a waterway of the same depth from Lake Ontario to the Hudson River is placed by this board at $506,000,000. Moreover, the cost of the former would be divided between the two countries, whereas the cost of the latter would fall entirely upon the United States. The number of locks on the St. Lawrence route would be from 7 to 9 as against from 18 to 20 for the route across New York State, and the number of bridges would be 8 on the former and 54 on the latter, only 17 of which could be fixed high-level structures. About 25 miles of the St. Lawrence waterway would consist of restricted channels as compared with 128 miles of such channels on the waterway through New York State. The New York waterway has no appreciable advantage in length of navigation season over the other waterway, but it does have an advantage in the matter of fogs and icebergs. In general, the St. Lawrence route has an advantage in time for European and Mediterranean ports, while a similar advantage, though applicable to less tonnage, applies to the New York waterway to South American ports, Pacific Coast ports, and the Atlantic Seaboard south of Boston.

Annual Cost and Saving—The total annual cost, including amortization in 54 years, interest on investment, maintenance and operation, is placed at $25,900,000 for the 20-ft. waterway, and at $28,800,000 for the 25-ft. waterway. These figures do not include interest during construction. Over against this is an estimated saving of $11,235,000 on the 13,450,000 tons handled through the 20-ft. waterway and of $22,500,000 on the 15,500,000 tons handled through the 25-ft. waterway.

Fatigue Strength of Cast Steel

Alternating-stress fatigue tests of cast steel, carried out at the University of Illinois by Prof. H. F. Moore, are reported in Bulletin 156 of the Illinois Engineering Experiment Station, just issued. The specimens tested were cast so as to avoid the liability of internal defects, and were distinctly better than ordinary castings. They ranged in tensile strength from 67,000 to 109,000 lb., according to the heat treatment applied. The ratio of endurance limit to ultimate strength was almost constant, ranging from 0.40 to 0.46. No similar correlation with elastic limit, yield-point, Brinell hardness or Charpy impact resistance was found. One of the types was normal cast steel, while the other was high in manganese, containing 1.71 per cent against 0.68 per cent for the normal steel.

Bituminous Surface Treatment for Sand-Clay Roads

Using a Tar Prime Coat, a Heavy Asphalt and a Light Oil Seal, a Durable and Economical Surface Is Secured

By N. S. Anderson

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Abstract of paper read at the Asphalt Paving Conference of the Asphalt Association at Washington, D. C., Nov. 8-12, 1926.

BASED on the results shown by a number of experimental sections of surface treatment applied since 1923 on the better class earth type roads, the South Carolina Highway Department has constructed during 1926, 70 miles of road with tar prime coat, and asphaltic second and seal coats.

The development of this type of road has resulted in an accepted construction technique. A few months before work is to be started on the surface treatment the old topsoil surfacing on the road is scarified, the necessary additional topsoil added, and the road shaped to proper crown. After traffic has had an opportunity for several months to compact this loosened topsoil the road is swept with a revolving broom. A tar prime coat is then applied, usually at a temperature of about 125 deg. F., and at a rate of ¼ to ⅓ gal. per sq.yd. The road is ordinarily closed to traffic and the prime coat allowed to dry for about 24 hours. Occasional pot holes are filled with crushed stone after the prime coat is applied. The second coat, a heavy asphalt oil, is applied at a temperature of around 300 deg. F., and at a rate of approximately ½ gal. per sq. yd. This is immediately covered with about 50 lb. per sq.yd. of crushed granite graded from 1¼ to ¼ in. This is rolled with a 3 or 5-ton three-wheeled power roller, after which the surface has the appearance of a crushed granite surfacing with but few signs of the bituminous material. The road is then opened to traffic, and after a lapse of several months a seal coat is applied to make the roadway more nearly impervious to water. This consists of a fairly light asphaltic oil applied at a temperature of around 175 deg. F. at a rate of approximately ⅓ gal per sq.yd. immediately covered with about 15 lb. per sq.yd. of coarse sand. The amounts of materials used on, and the cost of construction of, three typical jobs are:

(1) 10.83 miles treated for a width of 18 ft. in 1925. Tar prime coat 0.292 gal., asphaltic second coat 0.358 gal. and crushed stone 50.4 lb. per sq.yd. at a cost of $1,885 per mile. seal coat at cost of $202 per mile.

(2) 6.93 miles treated for a width of 20 ft. in 1926. Tar prime coat 0.3 gal., asphaltic second coat 0.352 gal. and crushed stone 54.1 lb. per sq.yd. at a cost of $1,846 per mile. No seal coat placed up to Oct. 10, 1926.

(3) 28.2 miles treated for a width of 20 ft. in 1926. Tar prime coat 0.263 gal., asphaltic second coat 0.376 gal. and crushed stone 54.2 lb. per sq.yd. at a cost of $2,060 per mile. No seal coat placed up to Oct. 10, 1926.

In maintaining the final roadway, both a heavy asphaltic oil such as is used in the second coat, and cold patch, are used. Crushed stone of a somewhat smaller maximum size than that in the original treatment is mixed with the cold patch, and the mixture is stored until it is taken out to the road on trucks. The patching done in place with the heavy asphaltic oil is somewhat the cheaper but has the disadvantage that the tendency of the average workman, particularly of a "green" one, to use altogether too much bituminous material, results in over-thick patches.

The maintenance costs of our first surface treatment of a topsoil road placed in 1924 on a seven mile stretch have not been kept separately for the two types of treatment but are rather interesting nevertheless. The seal coat cost $304 per mile and the first year's maintenance cost exclusive of the seal was $385 per mile. The second year's maintenance cost was $258 per mile and its present condition indicates that the cost during the third year will probably not exceed $300 per mile. These costs include work on the shoulders, ditches and culverts, etc. but do not include depreciation of equipment or cost of supervision by the division or headquarters offices and are for a route that would cost at least $600 per year to maintain properly as untreated topsoil road.

The first year's maintenance cost of the 10.83 mile stretch above was $451 per mile exclusive of the $202 per mile seal coat. This is about in line with the above, considering the fact that the treatment was some 2 ft. wider than on the older road and the quality of topsoil inferior.

Although the experience with this type of surface treatment has been comparatively short-lived, some tentative conclusions have been reached.

(1) This treatment is absolutely unsuited for roads that have a poor quality of sand-clay or other earth surfacing which will not in itself support the usual wheel loads of highway traffic.

(2) The treatment is suitable for roads having good quality topsoil surfacing, carrying a fairly dense traffic of which only a small portion are heavily loaded trucks.

(3) It is at least a valuable "stop gap" until funds become available for paving.

For instance consider the case of the first surface treatment placed in 1924 and previously referred to. The preparation of the topsoil surfacing cost less than $200 per mile, the original surface treatment not over $2,000 and the seal coat $304 per mile, the first year's maintenance $385 and the second year's maintenance $258 per mile. Thus the construction plus the maintenance cost divided over the two year period amounts to about $1573 per mile per year. The present condition of the road indicates that the third year's maintenance cost should not run over $300 per mile which would give a construction plus maintenance cost over a three year period of $1149 per mile per year; and even if it should become necessary to place the second seal coat before the expiration of the third year, this cost would be increased to only about $1249.

The construction costs of the work being done this year do not run much higher than those given above. The road, given as (3) above, a long haul job, cost about $209 per mile more for the preliminary work and $60 per mile more for the original surface treatment, a total increase of $269. The road indicated as (2) on which an unusually large number of curves were banked, cost $729 more per mile for preliminary work and $154 less per mile for original surface treatment, a net total increase of $575. The cost of the seal coat on these two roads should not be more than the $304 mentioned, and there is reason to anticipate that the maintenance costs will be very much higher.

These construction plus maintenance costs just given do not include cost, interest charges or depreciation of heavy equipment nor cost of engineering supervision given by the division and headquarters offices. However, if any amount in reason is added to cover this omission and the figures compared with the interest charges on the construction cost plus the cost of maintenance of the usual types of high class pavement (say 5 per cent on $25,000 plus at least $150 per mile for maintenance of shoulders and ditches, etc., a total of $1,400 per mile per year) one seems justified in concluding that (1) the surface treatment of existing topsoil roads has enabled the highway department to give its traveling public a much larger mileage of comfortably riding roads than would otherwise have been possible; (2) that during a period of three or four years, the cost of construction plus maintenance of the surface treatment should not exceed the interest charges on construction cost plus maintenance cost of a high class type paving; (3) that the resulting three or four years extension of life of the paving should at least take care of any anticipated increase in its construction cost due to the postponement; and (4) that it is well worth while for other localities, that may have similar conditions to meet, to investigate and experiment with this and other types of surface treatment.

Mistake Must Be Mutual to Vitiate Contract

A court decision noted by W. B. Douglass in *Professional Engineer* of November involves the question of abrogating a contract on the ground of mistake. It was held (Massachusetts, *J. T. Bowes Co. v. Inhabitants of Town of Milton*, 151 N. E. 116) that where a contract has been entered into under a mutual mistake concerning a material fact, equity will grant release; but a mistake of one of the two parties to a contract is not grounds for relief either in law or in equity.

Engineering Literature

A MONTHLY REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

Revision of Tratman's Track

REVIEWED BY R. B. ROBINSON

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RAILWAY TRACK AND MAINTENANCE: A Manual of Maintenance-of-way and Structures (formerly published under the title of "Railway Track and Track Work)—By E. E. R. Tratman, A.M., Assoc. Am.Soc.C.E., M.A.R.E.A., Associate Editor *Engineering News-Record*. Fourth Edition. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 490; 120 line cuts and halftones, 33 tables. $5.

The problems in the maintenance of railway track and structures become more serious and engrossing as modern locomotives and cars increase in size and weight, and train speeds also increase. The problems begin with studies of soil, topography, drainage, shrinkage, subsidence, and other factors affecting the ground upon which, or through which, the roadbed is constructed. They continue with the surfacing material or ballast, ties, rails and rail fastenings as well as the necessary bridges, culverts, tunnels, coaling and watering plants, terminals, roadway buildings, signaling, interlocking and other equipment of a railway.

Tratman's latest revision of his "Railway Track and Track Work," now renamed "Railway Track and Track Maintenance," comprehensively brings these problems and their solution down to the present minute in actual practice, with the language clear-cut and concise. The illustrations are well chosen and modern. Fourteen chapters are given to railway construction, including structures, appliances and materials, and an equal number to methods of doing maintenance work, including organization of forces, programming expenditures, accounting and reporting. A reference work of this scope has to be comprehensive enough to cover general conditions; therefore mention is made of practices in effect on several representative railroads in different parts of the country, and the reader or student is thus assisted in applying the information and selecting the methods and materials best adapted to the territory and conditions which he may be studying.

Some of the important details and trends in present-day maintenance work as covered in this book are as follows: Caution orders for protection of trains in operating over track that is in any unusual condition must be preceded by the placing of standard warning indications along the track. Water pockets under the track interfere with maintenance and even where ample drainage work has been provided by bridging, culvert construction and open ditching, there is often necessity for the larger use of tiling in releasing pocketed water to avoid soft spots in the roadbed. Maintenance of schedules, coupled with use of larger and heavier power, demands an increased ballast section and the use of the best quality of ballast obtainable.

As tie timber becomes scarcer, the use of the so-called soft-wood ties becomes necessary, and the shorter life of this timber calls for preservative treatment. It is obvious that where ties are preserved against decay, they must be protected against mechanical wear, which means a larger use of tie-plates than has been the custom. A larger use of rail anchors is also necessary in order to prevent creeping and to preserve gage and alignment, as well as to provide safer conditions at switches. More careful attention must be given to rail composition, rolling and handling, all the way into the track. It has been demonstrated that rail lengths of 39 ft. can be economically used, but greater lengths will probably not come into general use, because of car length limits in transporting, and while there are safety features in loading and unloading and handling into place with derricks, some handling by men and tongs will always be necessary.

The construction and maintenance of railroad crossings is a problem which must be carefully handled for each individual case, proper drainage and support being extremely important. Concrete roadway signs, fence posts, and metal cattle guards and metal guard aprons will be more and more used. With the wide use of power vehicles, smooth, hard-surface highway crossings are being called for. Higher ideals and comforts require consideration in the designing and maintaining of roadway buildings, including dwellings, depots and camp cars. The ends of economy and safety must be served by more extensive use of roadway machines.

Terminal facilities and yard layouts require careful study, particularly in connection with the modern trend toward longer runs of locomotives. Telegraph and telephone facilities and power lines must be carefuly located and properly maintained. More attention must be given to the possibilities of locating high voltage electric line crossings underground. Present-day economic requirements demand more careful attention to the programming and budgeting of maintenance work. This requires careful planning ahead and more detailed cost study, estimates, reports and supervision. Generally speaking, more attention must be given to personnel, morale, and efficiency in supervisory positions, as well as in working forces.

In my judgment Mr. Tratman's revised volume is a valuable reference book for practicing engineers, as well as an up-to-date source of information on materials and methods for use of student engineers contemplating entrance into the field of railway engineering. It is also admirably adapted to study by ambitious young men engaged in the railway office, along the track, at the bridges, or at the front.

Swiss Hydraulic Stations

GUIDE TO SWISS HYDRAULIC DEVELOPMENTS, 1926 EDITION (ENGLISH)—Zurich, Switzerland: Secretariat of the Association for the Utilization of Hydraulic Power. Cloth; 6x9 in.; pp. 538; profusely illustrated, 4 folding plates.

In 1921 the "Swiss Association for the Utilization of Hydraulic Power" published its first guide to hydraulic developments. This edition was in such demand that it ran out of print quickly, as did a revised edition in 1924. The present volume brings the work up to the end of 1925. It has been published in English and French and an Italian edition is contemplated.

Tables at the front of the book give data concerning all existing hydro-electric plants in Switzerland—name,

owner, river, flow, head, storage, output, ultimate capacity, output in kilowatts in 1924, and possible output in kilowatt-hours per year. Data concerning plants under construction and proposed are also given. Following the tables are descriptions in greater detail of all power plants of about 1,000 hp. or more. These descriptions usually include photographs and plans of the developments.

The book is a very valuable record of Swiss hydraulic developments.

Movable Bridges

REVIEWED BY HANS RODE
Bridge Engineer, Portland, Ore.

BEWEGLICHE BRÜCKEN. II Teil: Die Dreh, Hub und Rollbrücken, Brückenfähren—By Dr.-Ing. Ludwig Hotopp, Professor at the Hanover Polytechnical College. Hanover: Helwingsche Verlagsbuchhandlung. Paper; pp. 152; 358 illustrations. 25 reichsmarks in Germany. Special case for Vol. I and Vol. II 2.5 marks.

With the present or second volume Professor Hotopp completes his well-known treatise on movable bridges and deals with swing, lift and retractile bridges, also bridge ferries. Vol. I, which appeared in 1913, was devoted to bascule bridges. It is now nearly sold out and a new and revised edition is planned which will bring the presentation of the steadily more important bascule bridges up to date. During a lifetime the author has been active in construction work giving him a thorough experience in structural, hydraulic and even mechanical engineering; he is also an authority on theoretical mechanics. Thus equipped, he has been able to discuss and compare the various types of movable bridges from all important viewpoints.

The greater part of the second volume is devoted to swing bridges, either rim-bearing or center-bearing. In addition to a comprehensive general theory, 18 existing bridges are described, 3 of these being in the United States, 10 in Germany and 5 in other European countries. Of particular interest is the description of the swing bridge carrying the Bridgewater Canal across the Manchester Canal, in England. The chapter on lift bridges contains the description of four such structures. This type of bridge will probably in the future be used more frequently than heretofore for crossings with very heavy bridge traffic, inasmuch as a lift bridge readily permits the use of two decks which can be operated separately, the upper deck being used for light traffic and opened only for larger ships.

Professor Hotopp's book will, the writer feels sure, be of interest to American engineers who want to make a special study of the European practice in the important field of movable bridges.

Telphers and Ropeways in Britain

MODERN TELPHERAGE AND ROPEWAYS — By Herbert Blyth, M. Inst. C. E. Edinburgh: H. & J. Pillans & Wilson; New York: D. Van Nostrand Co. Cloth; 7x10 in.; pp. 155; 6 tables, 127 illustrations. $7.

European countries have developed and used telpherage systems and ropeways to a much greater extent than ever has been done in America. Telpherage systems were invented in 1882, according to the author, but received little development until after 1886. Ropeways, on the other hand, have been in use for nearly 1,500 years, but with the increase in the use of electric power telpherage systems have, in a few years, reached a similar state of mechanical refinement.

The present work deals chiefly with British practices and systems. Its main object is to set down in concise form the general principles which govern and the practical conditions which underlie the application of telpherage and ropeways to modern conveying methods and problems.

The book is divided into three sections: Modern Telpherage, Modern Ropeways, and Modern Cableways. The first section deals with telpherage as applied to coal and ash handling and the storage of minerals, the application of grabs and skip loaders, distant control, high telpher tracks of long span subject to wind pressure, and capital costs and maintenance costs in handling coke in gas-works. The second section discusses monocable and bi-cable systems, portable ropeways, and the "jig-back" and to-and-fro ropeway; practical considerations of design and construction; terminals, suspension railways, sheave mountings and load carriers. The section dealing with modern cableways is short. The detail drawings and illustrations of actual applications are excellent.

Tests of Composite Action

STEEL I-BEAM HAUNCHED IN CONCRETE—By Peter Gillespie, Professor of Civil Engineering, and R. C. Leslie, Research Assistant, University of Toronto. Bulletin No. 5, Section 2, University of Toronto Faculty of Applied Science and Engineering School of Engineering Research. Reprinted November, 1926. Toronto: University of Toronto Press. Paper; 6x9 in.; pp. 63; line cuts and tables.

To supplement and check the previous Canadian tests on the composite action of steel beams carrying reinforced-concrete slabs, the authors undertook a similar test, using an 8-in. I-beam encased in concrete and carrying a 3½-in. slab 20 in. wide. The result justified the conclusion that the two materials acted together as they do in reinforced concrete and developed a shearing strength in the concrete that in the opinion of the authors warrants a working stress of 240 lb. per square inch in horizontal shear. Following this test, they computed a complete series of tables of the carrying capacity of standard I-beams, from 27 in. to 4 in. in depth, with slab and encasement dimensions which they adopt as standard—bottom width of encasement equal to flange width plus 4 in., depth of concrete under beam 2 in., side batter 1 in 10, one-fifth of slab depth below top flange, effective width of slab eight times the slab thickness plus average width of encasement. These tables form the main part of the present bulletin.

Water Power Year Book

WASSERKRAFT-JAHRBUCH 1925-26—Von Oberbaudirektor K. Dantscher, ord. Professor, München; und Ing. Carl Reindl, München: Richard Pflaum. Cloth; 6x9 in.; pp. 382; 168 halftones and line cuts, 7 plates. 16 reichmarks, cloth, in Germany.

The current edition of this yearbook on water power developments is divided into five parts: I deals with development in the use of water power in the principal countries of Europe and has separate sections concerning each country. II takes up the use of water power in the industries, particularly the chemical and metallurgical industries. The combined use of water power and steam power is also discussed in this section. III takes up the design and construction of water power plants. IV is concerned with hydraulic machinery, particularly the Kaplan turbine. Part V. is an appendix of hydraulic information, including data on the Kaplan, Francis and propeller types of turbines.

PUBLICATIONS RECEIVED

DATA ON DAILY RIVER STAGES at river gage stations on the principal rivers of the United States for the year 1925 are now available. (Weather Bureau, U. S. Department of Agriculture, Washington, D. C.)

A REVISED EDITION of the Standard State Zoning Enabling Act, formulated by the Advisory Committee on Zoning, appointed by Secretary Hoover, is now available. (5c. from Superintendent of Documents, Washington, D. C.)

ARCTIC AND WESTERN HUDSON BAY stream flow data for the climatic year 1923-24 are given in Water Resources paper No. 46 of the Department of the Interior, Canada. For convenience in preparing these reports Canada is divided into four sections, Atlantic drainage (south of the St. Lawrence River), St. Lawrence and southern Hudson Bay drainage, Arctic and western Hudson Bay drainage, and the Pacific drainage. (Dominion Water Power & Reclamation Service, Ottawa, Ontario, Canada.)

FOUR PAPERS ON STREAM POLLUTION, presented in April, 1925, at the Cincinnati meeting of the Sanitary Engineering Division of the American Society of Civil Engineers, and since then printed in *Proc.* Am. Soc. C.E., Nov. 1925, and in weekly numbers of Public Health Reports, may now be had as Reprint 1063, a 51-p. pamphlet, (10c. from Superintendent of Documents, Washington, D. C.). The authors are W. H. Frost, surgeon, E. J. Theriault, associate chemist, H. W. Streeter and J. K. Hoskins, sanitary engineers, all of the U.S.P.H.S.

A STUDY OF TIDAL CURRENTS in the vicinity of New York Harbor, made with the aid of sealed bottles, primarily to throw light on allegations that the garbage and refuse of New York City, after being dumped at sea, is washed up on the beaches of New Jersey and Long Island is the subject of a report by Arthur S. Tuttle, chief engineer Board of Estimate and Apportionment. Mr. Tuttle concludes that garbage discharged at sea 20 miles from the Scotland Lightship "would become water-logged and sink long before it could ever reach the shore in any appreciable quantity."

New Books and Revised Editions

[*Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.*]

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS GUIDE, 1926-27: Containing Design and Specification Data, etc., Society's Transactions, Investigations of its Research Laboratory, etc., etc., also the roll of membership and a complete index. Volume 5. New York: American Society of Heating and Ventilating Engineers. Cloth; 6x9 in.; pp. 580; numerous halftones and line cuts. $3.

ANLEITUNG ZU GENAUEN TECHNISCHEN TEMPERATURMESSUNGEN—Von Dr.-Phil. Dr.-Ing. e.h. Osc. Knoblauch, Professor an de Technischen Hochschule München, Geheimer Riegerungsrat; und Dr.-Ing. K. Hencky, Privatdozent an der Technischen Hochschule Aachen, Leiter der wärmetechnischen Abteilung der I. G. Farbenindustrie A.-G. Leverkusen. Zweite völlig neu bearbeitete und erweiterte Auflage. München and Berlin: R. Oldenbourg. Paper; 6x9 in.; pp. 174; 74 line cuts. Paper, 9, cloth, 12 reichmarks in Germany.

A.S.T.M. TENTATIVE STANDARDS. Philadelphia: American Society for Testing Materials. Cloth or paper; 6x9 in.; pp. 1100; many line cuts and halftones; 227 Tentative Standards. Cloth, $8.50; paper, $7.50.

DER BAU LANGER TIEFLIEGENDER GEBIRGSTUNNEL—Von C. Andreae, Professor an der Eidgenössischen Hochschule Zürich. Berlin: Julius Springer. Paper; 6x9 in.; pp. 151; 83 line cuts. Paper, 13.2 reichmarks in Germany.

BUILDING MECHANICS—By W. G. Sheppard, B.A. (Cantab.) M. I. Struct. E., Civilian Educational Staff, Royal Air Force; Late open exhibitioner, St. John's College, Cambridge; Formerly Lecturer at the London County Council School of Building, Brixton. New York: Oxford University Press (American Branch). Cloth; 6x9 in.; pp. 264; 236 line cuts. $4.

Designed for "building and structural engineering students of our (British) technical schools other than those of university rank"; based on lectures by the author.

CEMENT, CONCRETE AND BRICKS—By Alfred B. Searle, Lecturer on Brickmaking under the Cantor Bequest; Consulting Expert in the Cement and Clay Products Industries; Author of "British Clays, Shales and Sands," "The Natural History of Clay," "Modern Brickmaking," "The Clayworkers' Handbook"; Joint Author of "Reinforced Concrete," etc. Second edition. [Outlines of Industrial Chemistry Series.] New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. 441; 115 line cuts and halftones. $6.

COASTAL CURRENTS ALONG THE PACIFIC COAST OF THE UNITED STATES—By H. A. Marmer, Assistant Chief, Division of Tides and Currents, U. S. Coast and Geodetic Survey. [Department of Commerce, U. S. Coast and Geodetic Survey, Special Publication 121.] Paper; 6x9 in., pp. 80; with line cuts and tables. 15c. from the Superintendent of Documents, Government Printing office, Washington, D. C.

CONCRETE PRACTICE: A Text Book for Vocational and Trade Schools—By George A. Hool, S.B., Professor of Structural Engineering, University of Wisconsin University Extension Division; and Harry E. Pulver, B.S., C.E., Associate Professor of Structural Engineering, University of Wisconsin University Extension Divison. New York and London: McGraw-Hill Book Co., Inc. Cloth; 5x8 in.; pp. 369; 158 halftones and line cuts; illustrated, appendices. $3.

ELEMENTE DER WIRTSCHAFTLICHKEITSBERECHNUNG VON WASSERKRAFTANLAGEN—Von Dr.-Ing. v. Gruenewaldt. Karlsruhe and Leipzig: Friedrich Gutsch. Paper; 6x9 in.; pp. 113; 26 line cuts; logarithmic and other tables. Paper, 8 reichmarks in Germany.

DIE FLUTWELLEN IN FLUSSMUNDUNGEN UND MEERESBUCHTEN: Eine rechnerische Behandlung ihrer Geschwindigkeit ihrer Stromungen und ihres Arbeitsvermögens—Von Dr.-Ing. H. Krey, Oberbaurat in Berlin. Mitteilungen der Versuchsanstalt für Wasserbau und Schiffbau in Berlin, Heft 3. Berlin: Guido Hackebeil. Paper; 6x9 in.; pp. 59; 40 line cuts.

GESCHIEBEBEWEGUNG IN FLÜSSEN UND AN STAUWERKEN—Von Dr. Techn. Armin Schoklitsch, o. ö. Professor des Wasserbaues an der Deutschen Technischen Hochschule in Brüns. Berlin: Julius Springer. Paper; 6x9 in.; pp. 108; 124 halftones and line cuts. Paper, 8.7, cloth, 10.2 reichmarks in Germany.

INTRODUCTION A LA STATIQUE GRAPHIQUE DES SYSTÊMES DE L'ESPACE—By Benjamin Mayor, Professor a l'École d'Ingénieurs et de la Faculté des Sciences de l'Université de Lausaunne. Préface de Maurice Paschoud, Professeur a l'École d'Ingénieurs de l'Université de Lausanne. (Cours de l'École d'Ingénieurs de l'Université de Lausanne. Lausanne (Switzerland): Librlarie Payot & Cie. Paper; 6x9 in.; pp. 78; 27 line cuts. 4 francs, in Lausanne.

THE MANUFACTURE OF PORTLAND CEMENT FROM MARL: Bulletin 4 of the University of Minnesota, Engineering Experiment Station.—By Raymond E. Kirk, M.S., Assistant Professor of Chemistry, University of Minnesota, Minneapolis: University of Minnesota. Paper; 6x9 in.; pp. 98; numerous halftones and line cuts.

STATISTIK DER DEUTSCHEN GROSS-WASSERKRAFTENANLAGEN: Mit Unterstützung der Deutschen Gesellschaft für Bauingenieurwesen und des Deutschen Wasserwirtschafts—und Wasserkraftverbandes E. V.—Bearbeitet von Prof. Dr.-Ing. techn. E. h. Adolf Ludin, Charlottenburg. Sonderdruck aus dem Jahrbuch der Deutschen Gesellschaft für Bauingenieurwesen 1926a. Berlin: G. B. M. H. Paper; 6x9 in.; pp. 15; map, chart, tables.

STEAMING TESTS WITH INDIANA COAL—By A. A. Potter, Dean School of Engineering and Director Engineering Experiment Station; A. W. Cole, Professor of Steam Engineering; W. E. Gray, Instructor in Mechanical Engineering; and J. P. Walsted, Assistant, Engineering Experiment Station, Purdue University. [Bulletin 26 of Engineering Experiment Station.] Lafayette, Ind.: Purdue University. Paper; 6x9 in.; pp. 199; linecuts, tables and summaries of tests.

TABLES ANNUELLES DE CONSTANTES ET DONNÉES NUMERIQUES DE CHIMIE, DE PHYSIQUE ET DE TECHNOLOGIE —Publiées sous le Patronage de l'Union de Chimie pure et appliquée. Volume V: Années 1917-1922; Deuxième Partie. Paris: Gauthier-Villars et Cie. Cambridge (England): Cambridge University Press. Chicago (Ill.): University of Chicago Press. Cloth; 9x11 in.; pp. 1934; illustrated.

The engineering section contains 143 pp. devoted chiefly to constants for timber (specific gravity and strength); cement, mortar, concrete, etc.; textiles, fabric and paper; lubricants; physical and chemical properties of fuels; and refractory materials. The French language and the metric system are used, but there is a detailed Contents in French, English, German, and Italian, besides running page heads to correspond. The American representative on the permanent international committee in charge of this enterprise is E. W. Washburn, of Washington. Most of the thirty collaborators are Parisian, but a few are German, Swiss or English.

TESTS OF THE FATIGUE STRENGTH OF CAST STEEL: A Report of the Investigation Conducted by the Engineering Experiment station, University of Illinois, in Co-operation with The American Steel Foundries—By Herbert F. Moore, Research Professor of Engineering Materials, in Charge, Investigation of the Fatigue of Metals. Urbana: University of Illinois. Paper; 6x9 in.; pp. 20; 8 halftones and line cuts.

THE THEORY AND PRACTICE OF MODERN FRAMED STRUCTURES: Designed for the Use of Schools and for Engineers in Professional Practice—By The Late J. B. Johnson, C.E.; C. W. Bryan, C.E., M.A., Chief Engineer of the American Bridge Co.; and F. E. Turneaure, Dr. Eng., Dean of the College of Engineering, University of Wisconsin. In Three Parts: Part I—Stresses in Simple Structures. Tenth Edition, Partly Rewritten. New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. 336; 43 line cuts. Part I, $3.50.

For this edition, Prof. W. S. Kinne, of the University of Wisconsin, has rewritten and enlarged the chapter on Deflection and Stresses in Redundant Members, giving especial attention to the use of graphical methods and adding several worked out examples.

A TRICHROMATIC COLORIMETER SUITABLE FOR STANDARDIZATION WORK—By J. Guild, A.R.C. Sc., F. Inst. P., F.R.A.S. Reprinted from the Transactions of the Optical Society, Vol. XXVII, No. 2, 1925-26. Cambridge (England); Cambridge University Press. Paper; 7x10 in.; pp. 129; 12 line cuts and halftones.

Letters to the Editor

A FORUM FOR DISCUSSION OF VIEWS OF ENGINEERS AND CONTRACTORS

Giving the Engineer His Due

Sir—New York is proud of the Grand Central Terminal and of the magnificent development, within the past twenty-five years, of Park Ave., north of that terminal. Many of its citizens can recall the conditions which existed in the old days, the separate waiting rooms of the New York Central, the New York & Harlem, and the New Haven and Hartford railroads, the intolerable and dangerous smoke and gas conditions of the tunnel, and the long stretch of property north of 42nd St., then useless for all but railroad purposes. Some of them realize that the great increase in the capacity of the terminal and its approaches following electrification has been an essential factor in the remarkable development of suburban territory in Westchester County and in Connecticut, now served by trains electrically operated. Obviously, the man who had the imagination to conceive and the courage and skill to accomplish the great engineering work which has produced the terminal as it now stands, converted many blocks of waste space north of Park Ave. into sites for scores of splendid apartment houses and other buildings and opened the door to the enormous increase of suburban residence territory should receive due credit; and when careless writers, either for the press or for more dignified periodicals, deprive him of that credit by ascribing it to others, great injustice is done.

When an artist produces a great painting, he puts his name on it. The same is true of the sculptor. The architect, also, usually is in position to protect himself and his reputation, to a considerable extent. But the engineer who is responsible for a great constructive work is frequently unable to secure for himself the credit which is justly his due. This is especially the case when he happens to be a man who feels it beneath his dignity to advertise himself. The great majority of scientists and engineers are unwilling to seek publicity. They do not willingly expose themselves to the camera of the press photographer, nor do they arrange interviews. Apparently, the only dignified way in which they can identify themselves with their work is by timely presentation, in the proceedings of an engineer society, of papers describing that work; and this, so far as the general public is concerned, attracts little attention.

My object in trespassing upon your space is to invite the attention of your readers to the subject and suggest that the engineering profession owes it to itself to consider the situation, and so far as practicable, find a remedy.

A most flagrant case of the injustice to which I refer is the publication in the November *Century* of an article by Webb Waldron entitled "Grand Central." It is a well-written paper, describing in popular language the transformation which has occurred during the last quarter of a century at the Grand Central Terminal on 42nd St. and northward along Park Ave. Every engineer who has kept in touch with great constructive engineering accomplishments in recent years knows that the man primarily and chiefly responsible for this great work was William J. Wilgus, chief engineer of the New York Central Railroad when he made the original plans and convinced President Newman that they were feasible, and vice-president from the time the work was authorized until it was completed in all of its basic features, and yet Mr. Waldron says in his *Century* article: "Whose idea was this, this gorgeous idea of renting out the roof of a railroad yard? 'It was Bill Newman's idea,' one New York Central man told me. Another said, 'Ira Place thought it out,' but nothing is clearer than it was no one man's idea; it just grew."

Unquestionably, President Newman and Mr. Place deserve due credit for their part in the work but it is equally unquestionable that the man to whom credit is chiefly due is Colonel Wilgus. He is the man who conceived it, who planned its essentials and who so long was in responsible charge of its execution. Mr. Newman, Mr. Place and the late George A. Harwood, who was one of Colonel Wilgus's assistants, would have been among the last to claim for themselves the credit which has been taken from Colonel Wilgus and given to them by careless, if not reckless, writers. It is notoriously difficult to overtake a lie, and apparently there is no way in which Colonel Wilgus or his friends can right such a wrong as has been done by Mr. Waldron's article in the *Century*. Its author, having had his mistake called to his attention, responds that there is no practical means by which the *Century* can be brought to make a correction.

A year or two ago, the daily press devoted considerable space to the completion of the Bear Mountain bridge. Politicians and others who, for the most part, had contributed little or nothing to the inception or construction of the bridge, were featured in photographs and type. According to my recollection, few of the articles, if any, even mentioned the name of Howard C. Baird, the chief engineer who designed it and supervised its erection. The president of the American Institute of Consulting Engineers, in a letter to the New York *Times*, promptly called attention to the oversight and the *Times* not only published his letter but handsomely made amends by an appropriate editorial.

What effective steps, if any, can be taken by the engineering profession or by the press to prevent injustice of the kind illustrated by the experience of Colonel Wilgus and Mr. Baird? Is the only answer that we live in an age of frenzied and reckless publicity and that every prominent engineer should employ a publicity agent? I am informed that at least one prominent daily newspaper in New York maintains a "Bureau of Accuracy and Fair Play" for the purpose of preventing and correcting mistakes. Would it be possible to induce other publications, and especially the technical press, to maintain similar bureaus, and might the great engineering societies advantageously appoint standing committees for the same purpose? It would seem, at least, that such committees would be in position to correct authoritatively and promptly such flagrant cases as those above referred to.

LEWIS B. STILWELL,
Consulting Engineer.

New York City,
Dec. 10, 1926.

Why Is Sledge Stone?

Sir—Nearly all highway engineers tell what a wonderful thing is drainage and how it is absolutely necessary to the maintenance of a road. They would make life miserable for a contractor whom they discovered in the act of dumping occasional boulders near the top of an earth fill, and they would be right. Then after the fill is finished they cut their trench, dump in 12-in. boulders and proceed to pound this same earth fill chock full of water pockets and leave future travelers to wonder why the road settles in places and can't seem to be induced to stand up as a well-behaved road should.

Instead of sledge stone, if four or five inches of sand or chatts were rolled into the prepared subgrade in two courses of equal thickness, and the crushed stone base, no stone to exceed 2½ or 3 in. in size, were placed on this fine base, the roads would stand up. Of course drains or bleeders through the shoulders should be provided at frequent intervals and would afford, in addition to drainage of the subgrade, a receptacle for the sledge stone. In this way the boys who can't get along without their sledge stone could use it where it would benefit the road.

Seriously, are not highway engineers ignoring entirely the feature of drainage? Drainage is the all-important factor to be considered in road construction, for with perfect drainage a good road can be built of almost any material; while without drainage, no material except solid rock will make a lasting road. Even good concrete in any economical thickness will fail if the subgrade is not properly drained, because it has not the strength to bridge the soft spots. In addition to the pavement failures, it is safe to assume that ninety per cent of the sloughing off of fills is due to this same lack of sub-drainage.

The writer is not engaged in highway work except as it falls to his lot, in general practice, to build a mile or two for some company or individual, or to pave some small town, and if this criticism shall start a discussion of this fundamental principle of road making, on which the life of the road depends absolutely, regardless of the type of pavement, he will be more than repaid for the short time consumed in writing this letter.

J. A. WRIGHT.

Eastland, Tex.,
Oct. 30, 1926.

Bridge Curbs and Railings as Protective Devices

Sir—On p. 774 of the issue of Nov. 11 you have drawn attention very pertinently to the necessity for more adequate lateral protection in the design of highway bridges by instancing the failure of the railing on the Connecticut Ave. bridge in Washington. The details of the construction of this railing are unknown, but the photograph on p. 806 of the same issue shows but two dowel bars through the sidewalk floor of the bridge; hence all that could be relied upon to prevent a truck in collision with the railing from leaving the bridge was the inertia of the railing.

It is essential that bridge curbs be made as high as possible, but they should not be so high as to foul the running boards of passenger vehicles. Allowing for spring compression and soft tires 9 in. is the maximum curb height which can safely be used. Where higher curbs are desired a stepped form may be used with the horizontal portion of the step not less than 9 in. wide.

BRIDGE RAILING 12 IN. THICK BY 3 FT. HIGH, DESIGNED IN PROPORTION TO LOAD CAPACITY OF BRIDGE

Your statement that automobile travel has made a new problem in bridge design is true so far as curb heights are concerned, but the necessity for keeping vehicles safely on the bridges has always existed. If it is not considered feasible to build such high curbs, protection must be afforded in the railing itself, if the railing is located where a vehicle may reach it.

Adequate curbs and railings exist on some of our largest monumental bridges, but the increasing list of accidents in which low curbs and weak railings figure prominently makes it imperative that this item in bridge design should not continue to be so generally disregarded.

Many years ago the writer adopted railings based on the loading for which the bridge is designed, and has suggested the following specification for their design:

> All railings located so that a truck may reach them shall be designed to resist a quiescent, normal, horizontal force per linear foot, applied at the top of the railing, of at least 2½ per cent of the total weight of the single typical truck for which the bridge is designed.

The adjoined photograph shows such a railing or balustrade built in 1920. It is 3 ft. high above the roadway surface and 12 in. thick, and has alternate spaces and balusters 6 in. wide each, so that the horizontal section of each baluster is 6x12 in. Each of the balusters is reinforced by four ¾-in. round reinforcing rods. The horizontal top and bottom members of the balustrade are also reinforced and the vertical rods are anchored well in the bridge floor. These railings are strong enough to resist a force of 1,000 lb. per lin.ft., which is 2½ per cent of the weight of a 20-ton truck. In the specifications above referred to the railing forms a member of the bridge which receives the same attention in design as any other part of the bridge and its strength varies with the loading for which the bridge is designed.

It has been argued that a railing to meet this specification must be solid, ugly and expensive, none of which has been found true in practice. Such railings as these have been placed on a great many bridges and have proven their strength on several occasions where collisions have occurred. In no case has the railing itself been forced out of line or damaged so that it could not be repaired in a comparatively few minutes. These railings have not proven expensive. Contract prices for such railings have averaged $5 per lin.ft.

The ordinary form of pipe railing suffers in comparison with these in every particular. A pipe railing of the same strength as the concrete railing above referred to would be made of 8 in. pipe with vertical posts 7 ft. on centers. The anchorage for such posts would form a serious problem and such a railing would be larger than any which the writer has known. It would occupy more space than the concrete railing and would cost for material alone more than twice as much per linear foot as the concrete railing. Its application to bridges, therefore, is entirely out of the question, and it is not necessary to comment upon its appearance.

Newark, N. J., Nov. 12, 1926.

CHARLES A. MEAD,
Chief Engineer, Division of Bridges and Grade Crossings, State Board of Public Utility Commissioners.

Theoretical Energy Losses in Intersecting Pipes

Sir—In looking over the valuable article on "Theoretical Energy Losses in Intersecting Pipes," by J. C. Stevens, printed in *Engineering News-Record* of July 22, 1926, p. 140, I notice two misprints which, if corrected in pencil, in the bound volumes of various subscribers, may save a few moments of uncertainty to anyone who refers to the article in the future.

The first misprint is in the sixth line up from the bottom of the first column, in which

$\left(\frac{q_n}{g_n}\right)^2$ should be $\left(\frac{q_n}{a_n}\right)$ — (without exponent);

and the second occurs in equation (9) in which

$\left(1-\frac{V}{v}\right)$ should read $\left(1-\frac{V}{v}\right)^2$

FRANK S. BAILEY,
With Metcalf & Eddy, Consulting Engineers.

Boston, Mass., Nov. 13, 1926.

Methods to Prevent Concrete from "Gaining Water"

Sir—The problem of concrete's "gaining water" discussed by Mr. Greene in his article on the Robert St. bridge at St. Paul and commented on editorially in *Engineering News-Record*, Nov. 11, 1926, p. 785, was encountered by the writer while superintending the construction of a small dam on the Perkiomen Creek at Green Lane, Pa. The dam was 6 ft. high and 60 ft. long and had a 6-in. reinforced concrete deck 10 ft. wide on a 10 per cent slope.

It was found that in order to get a concrete which would stay in the form at the end of the pour on a deck with such a steep slope and yet not be too dry to be workable at the start, it was necessary to begin with a wet mix and to cut down on the water as soon as a layer covering the bottom had been poured. On the small sections poured on this job it was possible to carry out this idea further by pouring wet batches on the dry parts and dry batches on the wet spots, though in a job of any magnitude an attempt to do this would cause confusion.

The writer agrees with Mr. Greene on the advisability of having an inspector "in the hole" with authority to vary the consistency of the concrete. Since the necessity of starting the pour with concrete wetter than the average in order to obtain workable concrete is as great as the necessity of finishing the pour with drier concrete, would it not be desirable, moreover, where it is not feasible to have such an inspector, to write specifications providing for a decrease in the slump for the last half of the pour? This would apply to all parts of the work where the phenomenon of "gaining water" was to be expected, such as mass concrete, slabs, walls big enough for men to work in the concrete, and so forth. Working concrete of these types if only one slump is specified is like suffering from a drought followed by a flood.

Philadelphia, Pa., Nov. 28, 1926.

WILLIAM W. K. FREEMAN,
Junior Engineer, Hydro Division of The U.G.I. Contracting Co.

Defense of the Price Current Meter

Sir—In a "brilliantly written [German] pamphlet," according to a review by I. Gutmann in year issue of Nov. 18, p. 840, Dr.-Ing. A. Staus "discusses the precision of meter gaging in canals and closed conduits." Says he, "The Price current meter . . . does not register the proper component of the stream . . ." and is therefore ". . . faulty in principle . . . unreliable and obsolete—in short it should be relegated to a museum of curiosities." Theory against practice again. The answer, as to other foreign criticisms of things American, might be that we are more interested in results than refinement, that European conditions do not apply to ours; or we might ask to be shown a better device.

Current meters are used, practically speaking, to determine not velocity but discharge of streams, ditches, pipes, wells, turbines, etc., in terms of corresponding heads, gate openings, gage heights, or pressures. Studies may relate to undeveloped or developed water resources. For all work classed as preliminary under the first heading, and likewise for many investigations of developed streams, accuracy beyond five per cent would fill no economic need. Even Dr. Staus has demonstrated that the Price meter will check discharges within these limits. Therefore it is at least not unfit for fully three-fourths of the work now being carried on in this country.

Dismissing for the moment cases where greater refinement is desired, let us consider the general field of American practice. Dr. Staus argues that the Price meter does not properly register component velocities near the banks nor take cross currents into consideration. These factors may affect the gaging of canals with which he is familiar but hardly apply to ordinary river conditions. Most of our streams are unconfined by walls or levees and slope gradually from maximum to zero depth. Sections near the banks carry such a small part of the flow that errors here are usually negligible. After all, it takes a noticeable angle to cause one per cent error. So, for horizontal deviations, corrections may be applied. Even if the unknown vertical component were obtainable, measurements would still be subject to the assumption that the 0.6 velocity or average of 2.8 observations is the mean in section. There are yet other unavoidable assumptions both in methods of determining discharge at any given time and in preparing for human use records over a period. But whatever might happen in theory is taken care of by our old friend Compensation of Errors.

Not to rely unduly on compensating factors, certain checks may be made. If discharge measurements at a given station are consistent with each other, if they plot in a smooth curve with reference to gage heights one has a check of a sort though not positive. To go a step farther, suppose the total measured flow in two or more branches of a river is found to equal that in the main stream. Better yet, suppose the records of a stream gaging station for some given period are checked with those of a nearby power plant located on the same stream and fitted with the best of modern equipment; checked and found almost identical. With these conditions satisfied, no reasonable doubt remains that the records in question are the best possible under methods now known. Such results are obtained year after year by none other than that old museum piece, the Price meter—in the hands of experienced hydrographers. Precision is determined rather by methods of arriving at daily mean gage heights than instantaneous values of discharge, but this is hardly to the point, practice being essentially standard for discharge measurements. It is the meter, not the method, which is indicted.

In the final analysis, a current meter of some sort has to be used wherever quantities of water are involved beyond experimental driblets. The use of weirs, slope formulas, Venturi meters, chemical solutions, or what not depends in each case on some formula or assumption. In the end, one goes to the current meter for a reliable rating. If not the Price meter, then what? Dr. Staus favors the Ott meter, a direct or propeller type. The U. S. Geological Survey abandoned the direct type some years ago, except for measuring discharge in small pipes, because its practical disadvantages outweighed its theoretical superiority. Direct meters have mechanical weaknesses; do not stand up under hard usage; are subject to change in rating if struck by floating ice or débris; easily clog with weeds; do not accurately register low velocities. Attempts have been and are being made to remedy these faults. In the meantime, the rugged, reliable Price functions admirably under conditions good and bad alike. The Au (improved Price) meter has the additional advantage of giving very low velocities with accuracy hitherto unknown.

True, stream gaging is yet in its infancy. Some day bigger and better meters will be built. Then, but not until then, may antique dealers dispose of our present equipment to serve as weather vanes, ornaments for nickel-plated radiators—or museum specimens.

K. K. HOYT,
Junior Engineer, Water Resources, Branch,
U. S. Geological Survey.

Albany, N. Y.,
Dec. 4, 1926.

Vertical-Beam Action in Test Dam

Sir—In your issue of Nov. 18, p. 828, is published the first partial report of tests of the Stevenson Creek dam, which report gives some data on deflections. Your editorial comment refers to the anomaly of the deflection at the top near the quarter point being *upstream*. This is easily explained by, and is clearly a further proof of, the theory of vertical-beam action being one of the major controlling actions in the dam.

The action is as follows: Consider the top several feet as a horizontal arch receiving the top reaction of the elementary vertical beams as loads. These loads will be much greater near the crown (where the vertical beams are longest and subject to greater pressures) than about the haunches. This excess load at the crown depresses the arch there and bulges it out at the haunches where the load is light.

The deflections in the vertical sections near the crown plainly show vertical-beam action.

The theory of vertical-beam dams and the effect in arch dams is given in a bulletin by the Missouri School of Mines under the title "A Study on Reinforced Concrete Dams," Bulletin 3, Vol. 8, May, 1925. Copies may be gotten from the Librarian.

ELMO G. HARRIS,
Professor of Civil Engineering,
School of Mines and Metallurgy,
University of Missouri.

Rolla, Mo.,
Nov. 29, 1926.

Crowded Convention Programs Explained

Sir—I am in hearty accord with the attitude taken in the editorial note on "Crowded Programs" in your issue of Nov. 25, 1926. The shoe is a perfect fit for the last annual convention of the American Society for Municipal Improvements, over which meeting it was my duty to preside.

For several years past, I have protested against crowded programs as preventing discussion. I made up my mind when elected president of the A.S.M.I. that this objection would be eliminated, but when the Committee on Programs (of which I was a member) met and surveyed the field it appeared doubtful whether the program could be properly filled by those who consented to prepare suitable papers, and committee chairmen were requested to help out. This was done so effectually that when the program was compiled it was too full to afford any substantial time for discussion but it was then too late to decline papers already prepared at the request of committee chairmen, and I presume this is a repetition of the experience of all program committees of technical societies.

The A.S.M.I. committee endeavored, early in the year, to have the papers prepared and presented to it months before the convention so as to be able to pick the chaff from the wheat, but the writers would not come across, which is not unusual, and this failure brought about the unfortunate situation indicated.

Your objections to crowded programs are well taken and if you can, through an occasional warning, bring about an improvement you will do a great service to those who attend annual conventions of technical societies.

T. CHALKLEY HATTON,
Ex-President, A.S.M.I.

Milwaukee, Wis.,
Dec. 1, 1926.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Hudson County Boulevard Bridge Plaza Opened to Traffic

The Hudson County Boulevard Bridge Plaza built over the Pennsylvania and the Hudson & Manhattan railroads adjacent to the Journal Square station in Jersey City, N. J., was formally opened to traffic Dec. 9 at 9 p.m. Governor A. Harry Moore of New Jersey, Mayor Frank Hague of Jersey City and Judge William H. Speer were the principal speakers at a dinner given under the auspices of the Jersey City Chamber of Commerce, which preceded the official opening.

The bridge was built entirely of reinforced concrete. It is composed of two main arch spans each having length of 140 ft. 6 in. These spans consist of thirteen separate arch ribs 5 ft. 6 in. in width and 12 ft. apart to give extraordinary plaza width of 212 ft. 6 in. The bridge deck or roadway is 50 ft. above the track level. Bus operation and their terminal facilities were important considerations in planning the structure which is one of the first attempts to provide these facilities in the central part of a city.

The 212 ft. 6 in. bridge deck is composed of three roadways separated by two safety isles or platforms each 17 ft. 6 in. in width. The westerly roadway is used for south-bound traffic, the easterly roadway for north-bound traffic and the center roadway with its safety isles is to be used as the bus terminal. The adopted plan is a modification of the original plan which was depicted by model and described in *Engineering News-Record*, Aug. 23, 1923, p. 306.

There were very many interesting features in construction — a limited space for plant layout, maintaining uninterrupted the railroad, and pedestrian and vehicular traffic. Plans were prepared and supervision of construction carried on in the office of A. Burton Cohen, consulting engineer, New York City, collaborating with Frank J. Radigan, county engineer. Stillman, Delehanty & Ferris Co., Jersey City, N. J., were the contractors. Two years were required to complete the structure which cost $1,400,000.

To Confer on Additional Water for New York City

A joint official conference on an additional water supply for New York City and on a possible increase in water rates to finance the project will be held on Jan. 10 at the instance of Mayor Walker. The conferees will be the members of the Board of Estimate and Apportionment, the Board of Water Supply, and the Commissioner of Water Supply, Gas and Electricity. Specific projects to be considered are the plan for a large gravity supply from counties east of the Hudson River and an emergency well supply (see *Engineering News-Record*, Oct. 21 and Dec. 9, 1926, pp. 670 and 972).

Engineering Fifty Years Ago

From *Engineering News* of December 16, 1876

WITH the late rains and the increased flow of water over the Croton dam, one source of anxiety to New Yorkers has dried up, and the papers have dropped all mention of the water famine that threatened so lately.

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OPERATIONS on the Sudbury River conduit of the Boston Water Works have been suspended for the winter.

Col. M. H. Smith, N. Y. Water Supply Engineer, Dies

Had Served City Almost 40 Years—Retired on Dec. 3—Military Funeral Held Dec. 12

Col. Merritt H. Smith, since 1914 chief engineer of the Department of Water Supply, New York City, died on Dec. 8. He had been ill since last September. On Dec. 3 he was retired from his position after forty years of almost continuous service to New York City in various capacities. A military funeral, attended by the 104th Field Artillery, which he commanded in the World War, was held on Dec. 12.

Colonel Smith was born in New York City on May 21, 1862, son of Merritt Haviland and Mary Adelia (Howard) Smith. He graduated from Pennsylvania Military College with the degree of civil engineer in 1880. After studying law for a time he was with the Pittsburgh & Western R.R. as an engineer, for three years.

He entered the service of the city of New York in 1884, and continued there until 1890, as engineer on the old and new Croton aqueducts. He then took up general engineering work in connection with land development in Florida, but in 1892 he returned to the service of New York City, this time in the Department of Finance, in which department he continued until 1906, as assistant and principal assistant engineer, chiefly on paving work. During this period he was also, from 1900 to 1902, park commissioner for the city of Yonkers and police commissioner for that city during 1905 and 1906.

Appointed Department Engineer

With the beginning of the work on the new water supply from the Catskill Mountains, he was appointed department engineer to the Board of Water Supply of New York City, and placed in charge of the Southern Aqueduct Department, which covered all of that portion of the Catskill work from the Hudson River crossing south to the

(*Continued on p. 1012*)

Port Authority Sells $20,000,000 Fort Lee Bridge Bonds

Fourteen bids for an issue of $20,000,000 of bonds for construction of the Hudson River bridge between 178th St., Manhattan, and Fort Lee, N. J., were received by the Port of New York Authority on Dec. 9. Three groups of bidders submitted the bids. The issue was awarded to the group headed by the National City Co., on its bid involving the following specifications; coupon rate 4 per cent, purchase price 95.6377, maturity 1936-1950, redemption price 100.

This issue is part of an authorized issue of $60,000,000 for the bridge, but it is estimated that only $50,000,000 will be required to complete the bridge ready for traffic at about half its ultimate capacity. The structure is a suspension bridge of 3,500-ft. main span and two 650-ft. side spans, with main deck carrying three roadways totaling 88 ft. wide, and four single-lane roadways bracketed out to either side of the truss posts at a lower level. Its construction is estimated to require a time of 5 to 6 years.

The bonds are secured directly by the revenues of the Fort Lee bridge, but are also a general obligation on all revenues of the Port Authority. The prior bond issue of the Port Authority, $14,000,000 for the construction of two cantilever bridges across Arthur Kill between Staten Island and the New Jersey mainland, are also a specific and general obligation. Toll operation of the bridges is required until the bonds are retired; after that they may be terminated or may continue.

The Arthur Kill bridge bonds were sold in March, 1926, on a 4½ per cent coupon rate, at a price of 97.25, making an effective interest rate of 4.77, as against 4.242 for the Fort Lee issue.

Approval of plans for the Fort Lee bridge was given by the War Department Dec. 13.

Two-Dakota James River Water Treaty Proposed

Studies are being made for a possible treaty between North and South Dakota under which the spring flow of the James River would be stored in North Dakota to maintain a higher flow the rest of the year for water supply and sewage dilution. Jamestown, N. D., with a population of some 8,000, is facing lawsuits from riparian owners on account of alleged nuisance caused by the discharge of its sewers into the river. Huron, S. D., with a population placed at 12,000, faces possible water shortage each year when the river is low and also has sewage disposal troubles like those of Jamestown. The state engineer department of North Dakota (H. C. Frahm, state engineer, with J. N. Roherty and R. E. Kennedy, assistant state engineers), is studying the problem outlined above.

Control of Bathing in New Jersey Water Supplies Effected

After much agitation, more particularly by the municipal authorities of Jersey City, to the end that the New Jersey State Department of Health should prohibit bathing in the public water supplies of that state, the department took under consideration the addition to the state sanitary code of a chapter on that subject. The final outcome, after a number of public hearings, was the supplementary chapter or "amendment" which follows:

"1. No person or persons shall bathe in any river, brook, stream, lake, pond or reservoir in this state, the waters of which are the source or one of the sources of a public water supply for domestic use, if said bathing pollutes or tends to pollute said water for potable purposes.

"2. No person or persons shall maintain or cause, suffer, or permit to be maintained any bath-house, pavilion or other public place of entertainment, adjacent to any river, brook, stream, lake, pond or reservoir in this state, the waters of which are the source or one of the sources of a public water supply for domestic use, if the maintenance, use, operation or occupancy of such bath-house, pavilion or other public place of entertainment pollutes or tends to pollute said water for potable purposes.

"3. If, upon examination and investigation, the Department of Health of the State of New Jersey shall determine that bathing in any such river, brook, stream, lake, pond or reservoir pollutes or tends to pollute the waters thereof for potable purposes it shall prohibit bathing therein.

"4. If, upon examination and investigation, the Department of Health of the State of New Jersey shall determine that the maintenance, use, operation or occupancy of any such bath-house, pavilion or other public place of entertainment pollutes or tends to pollute the waters of any river, brook, stream, lake, pond or reservoir for potable purposes, it shall prohibit the use, operation or occupancy of such bath-house, pavilion or other public place of entertainment.

"5. For the purpose of enforcing these regulations the municipality or municipalities or persons or corporations furnishing said water for potable uses may designate or detail to the Department of Health of the State of New Jersey person or persons who shall be assigned as special inspector or inspectors by the said department, and the said municipality or municipalities or persons or corporations shall bear and pay the expense and cost of the person or persons so assigned in such capacity.

"6. These regulations shall take effect immediately."

Col. Merritt H. Smith Dies

(*Continued from p.* 1011)

city line, including also Kensico and Hill View reservoirs. In 1910 he became deputy chief engineer of the Board of Water Supply, and in 1914 was appointed chief engineer of the Bureau of Water Supply of the Department of Water Supply, Gas and Electricity, New York City.

His long experience in military service began when he became a member of the 7th Regiment, N. G. N. Y., in 1880. He served with Squadron A in 1896-1907, as captain and major of the First United States Volunteer Engineers in Porto Rico during the Spanish-American War, building and repairing bridges. He resigned his captaincy in 1907, but re-entered the service again as captain of the First Cavalry early in 1912, and shortly thereafter was promoted to lieutenant-colonel. He was made lieutenant-colonel of the First Field Artillery in 1914.

On June 19, 1916, he was ordered to the Mexican border with First Field Artillery, N. G. N. Y. He entrained with his regiment for Texas, July 3, 1916. On Oct. 9, 1916, he returned to duty in the Department of Water Supply, and on Nov. 15, 1916, he was mustered out of the federal service, but re-entered it on June 30, 1917, with the 104th Field Artillery, of which he was colonel. He served overseas from June 30, 1918, to Jan. 3, 1919, having been in the Meuse-Argonne offensive. He was discharged from the federal service on Feb. 12, 1919, and shortly thereafter resumed his position in the New York Department of Water Supply.

He was a member of the American Society of Civil Engineers, the American Water Works Association, the Municipal Engineers of the City of New York, and the Chamber of Commerce of the State of New York.

Colonel Smith was a man of outstanding ability and personality, of military bearing, strong and vigorous in every action, jovial and filled with life and humor.

News-Record Offers Messenger Service at Road Show

During the Road Show at the Coliseum in Chicago Jan. 10-14 a unique service will be offered engineers, contractors and equipment and material manufacturers and distributors by *Engineering News - Record* and *Successful Construction Methods*. It will consist in messenger, local telephone and information service.

At the booths which these two journals will occupy (Ballroom Booths 10, 11, 20 and 21) will be maintained a message receiving and delivery service. Anyone can call Victory 3630, leave a message for any other person, or ask that it be delivered without charge to any booth in the Coliseum. Telephone switchboard service will be available free of charge for local Chicago calls. There will also be distributed classified directory lists of all equipment and materials at the show to permit engineers and contractors to make inspections of particular booths with the minimum loss of time.

State Development of Power in New York State Outlined

Governor Smith of New York, speaking before the Survey Associates at New York on Dec. 13, outlined his stand on the present law concerning the development of water power in the state and his plans for a power authority to take over and develop the remaining power sites, chiefly those on the St. Lawrence River.

Since the report in *Engineering News-Record* of last week on his opposition to the licensing of private corporations to develop the St. Lawrence was written Governor Smith has been successful in preventing the issue of the licenses, both applications having been withdrawn under the threat of litigation over the powers of the Water Power Commission. Under the reorganized state government the governor will have veto power over the actions of the new board but he stated that the new commission will be even worse than the old because there will be no state engineer on it. He stated also that neither commission has the time nor ability properly to study and prepare plans for development of state power.

Governor Smith proposes to set up a power authority, a body corporate similar to the Port of New York Authority, which would be empowered to issue bonds for the purpose of building power plants. He would appoint to this power authority some of the foremost men in the water power field. They would be required to prepare a comprehensive plan for the development of the state's undeveloped water power resources and to submit it to the legislature for its approval. The plan must show that it is financially sound and that contracts can be made for the sale of power to distributing companies at the power houses. If necessary, the state will supply the initial funds for the work of the power authority but after it is once established it must be able to sell its own bonds.

Speaking at the same meeting, Elon H. Hooker, president of the Hooker Electrochemical Co., proposed that a similar body be set up to take over the operation of Muscle Shoals, except that this body should be made up of men familiar with the processes of producing nitrogen. His proposed organization would be a semi-public corporation which would pay its own operating expenses out of one quarter of the income of the nitrate and power plant and would turn the other three fourths over to the government to be used by the Department of Agriculture in educating the farmers in the use of concentrated fertilizers.

St. Lawrence Commission Meets

The United States St. Lawrence Commission held a meeting in Washington on Dec. 10 to consider the recent report of the joint board of engineers on the St. Lawrence Waterways project. A report to the President was ordered drawn up to set forth its conclusions. This report will be ready for presentation about Dec. 20.

Arizona Applies for Colorado River Dam Permit

The Board of Directors of state institutions for Arizona has applied to the Federal Power Commission for a preliminary permit covering a project on Colorado and San Juan rivers in Coconino County, Arizona, and San Juan County, Utah. The Arizona officials in their application state that they propose to build a dam 693 ft. high at Glenn Canyon site No. 1, which is four miles above Lee's Ferry. Such a dam would back up the water 205 miles. The application states that this dam and reservoir are to be an integral part of the Arizona high line reclamation project. The power would be used "to supply the power markets of Utah, Colorado, New Mexico and Arizona."

This application represents a new phase of the agitation in Arizona for wholesale utilization of the power and water of the Colorado within the state. Previous state proposals for dams involved sites near the west end of the canyon section along or east of the Arizona-Nevada boundary, while the new application concerns a site several hundred miles farther upstream, and in fact wholly within the upper basin, as defined in the Colorado River Compact. Like prior Arizona proposals, however, this one contains the feature of using the dam to divert water (or supply power for pumping at a lower diversion point) for irrigation supply to great areas of Arizona lands by way of tunnels through the mountains and high ground.

Under the resolution of the Federal Power Commission of Oct. 28, no present consideration will be given this application or any others involving streams in the Colorado basin.

New Jersey Sanitary Association Holds 52nd Convention

Besides papers on topics designed more specifically for health officers, the fifty-second annual convention of the New Jersey Sanitary Association, held at Asbury Park, Dec. 3 and 4, took up reforestation, watershed conservation, the scientific basis of ventilation, and camp sanitation. Both the outgoing and incoming president are engineers, although the former was chosen on the strength of his nearly thirty years of service as health officer of Elizabeth, N. J. The new president is Chester G. Wigley, consulting engineer, Atlantic City.

The retiring president, Louis J. Richards, took reforestation as the subject of his address, dwelling on its relations to water supply, recreation and the country's timber supply.

In an address on water conservation, Cornelius C. Vermeule, consulting engineer, New York City, was chiefly destructive, opposing the recommendations of the New Jersey Water Supply Commission for state purchase of lands for future municipal supplies, disapproving both the Long Hill and the Chimney Rock schemes for the future water supply of northeastern New Jersey, and arguing against police power sanitary restrictions on the use of water gathering grounds, particularly bathing, and for full compensation to property owners in case sanitary restrictions are enforced. He summed up his argument for compensation by asserting repeatedly that with water delivered in homes for 5c. a ton consumers can well afford to pay additional for any sanitary protection.

Earle B. Phelps, professor of sanitary science, Columbia University, outlined the newer scientific conception of ventilation and Herbert H. Morse, business manager, New Jersey Department of Public Instruction, divided the findings of the scientists composing the New York State Ventilation Commission in favor of open window ventilation for school buildings and argued for the old rule of 30 cu.ft. of air per pupil per minute, by means of forced ventilation, required by statute in New Jersey and many other states.

Camp sanitation from various progressive viewpoints was presented in a group of papers by Charles A. Holmquist, director, division of sanitation, New York State Department of Health, H. M. Freeburn, district engineer, Pennsylvania Department of Health, E. R. Carrich, Boy Scouts of America, Trenton, N. J., and C. K. Blanchard, assistant epidemiologist, New Jersey Department of Health.

The technical proceedings closed with an inspiring address on the health education movement, by Prof. Charles E. Turner, Massachusetts Institute of Technology.

City Manager Plan Proposed

As the result of a suggestion to abandon the city commission plan and go back to the aldermanic plan of government at Wheaton, Ill., a movement has been started to adopt the city manager plan. This city, of about 4,000 population, has been in general well satisfied with its city commission, but people who think certain sections have not been getting their share of improvement work are urging return to the ward system.

Baltimore Awards Contract for Municipal Building

The Board of Awards, city hall, Baltimore, has awarded the contract for constructing the municipal building to J. Henry Miller, Inc., at a price of $1,498,000. Other bids were: George A. Fuller Co., $1,525,000; M. A. Long Co., $1,521,465; Consolidated Engineering Co., $1,528,750; Charles L. Stockhausen, $1,537,600; Sinclair & Quigg, $1,694,000; Henry L. Maas & Son, $1,695,312.35; Carozza Construction Co., $1,698,000; P. C. Streett Engineering Co., $1,640,000.

The new building will cover a ground area 208 ft. 6 in. by 149 ft. 8 in. The height will be approximately 173 ft. above the street level. With floor area of 160,000 sq.ft. the cubic content will be 2,880,000 cu.ft.

The basement will be used largely for a municipal garage. The first floor will house those departments which have direct contact with the public, such as the Bureau of Receipts, the Bureau of Buildings, and portions of the Health Department. On the second, third and fourth floors will be the Appeal Tax Court, the clerical forces of the Bureau of Receipts, and a large portion of the Department of Public Works. The upper floors are to be occupied by the remaining divisions of the Department of Public Works and the Department of Health.

The building is to be built from a loan of $2,000,000, which was voted for the purpose of acquiring land and bearing the cost of construction.

William H. Emory, of Baltimore, is the architect.

WASHINGTON NOTES

ARGUMENTS for and against the adoption of the metric system of weights and measures were made before the Committee on Commerce of the Senate Dec. 10 and 11.

The advocates of the metric system urged the passage of a resolution introduced by the late Senator McKinley which proposes that the director of the Bureau of Standards conduct an investigation to determine the advisability of adopting the metric system for general use throughout the United States. Provision also is made for the director, if he should see fit, to carry into effect a plan to encourage the general use of the metric system.

Another resolution introduced by Senator Gillett provides for the altering of the yard, quart and pound so as to make them the exact counterparts of the meter, the liter and 500 grams.

COMPLAINT has been registered with the Interstate Commerce Commission by the Inland Waterways Corporation asking that the rail lines at Dubuque, Iowa, be required to establish reasonable joint through rates on classes and commodities to St. Paul and other points. It is contended that the refusal of the rail carriers to provide for this interchange of freight with the barges on the Mississippi constitutes a violation of Section 500 of the Transportation Act.

THE death of Senator McKinley, of Illinois, prevented the firing of the first gun in the Muscle Shoals fight during the first week of Congress. Arrangements were complete for the recognition of Senator Deneen, the chairman of the joint Muscle Shoals committee, to prevent the matter but the death of his colleague made it necessary for him to leave at once for Illinois.

Another plan for the lease of Muscle Shoals has been put forward in a bill introduced by Senator Ernst, of Kentucky. The only sponsors of the proposal who appear are three former state commissioners of agriculture, John W. Newman, of Kentucky; A. P. Sandles, of Ohio, and A. L. Sponsler of Kansas. C. Bascom Slemp, former secretary to President Coolidge, has been active in the presentation of this proposal.

The Ernst bill proposes the incorporation of the Farmer's Federated Fertilizer Corporation under a federal charter. Since the corporation does not furnish capital or incur liability it is anticipated that the plan will meet strong opposition.

While the bill states that the corporation expects to produce not less than 40,000 tons of nitrogen after the fourth year, there is no guarantee of such production. There also is uncertainty as to how the lease may be terminated. Objection also is raised to the lack of definite requirements with regard to the distribution of power not needed for fertilizer manufacture.

Another point raised against the bill is the clause exempting from taxation a concern organized for profit. There is no limitation placed on the profits.

ADVANCES of $45,000,000 of federal money for the construction of a dam in the Columbia River at Umatilla Rapids are sought by Representative Sinnot of Oregon. In a bill introduced at the opening of Congress Mr. Sinnot proposes that the Secretary of the Interior be authorized to "equip, operate and maintain a complete plant and incidental structures suitable for the fullest economic development of electrical energy."

Construction of New Railroad Into Mobile Authorized

The construction of an extension of the Alabama, Tennessee and Northern R.R. from Summit, Ala., in a general southerly direction to the port of Mobile, a distance of approximately 30 miles, has been authorized by the Interstate Commerce Commission. The present main line of the railroad extends from a connection with the Southern Ry. at Calvert, Ala., in a westerly direction to Summit, about nine miles, and then in a northerly direction to Reform, Ala., a distance of 177 miles to a connection with the Mobile & Ohio R.R.

Construction of the new line is expected to start within the next two months. The new line will have maximum grades of 1 per cent and a maximum curvature of 4 deg. The estimated cost is $937,000.

The proposed railroad is expected to form an important feeder line for the new port facilities being built by the state of Alabama at Mobile.

Denver City-County Building Construction Held Up

Judge Julian H. Moore, in the district court of Denver, Colorado, Dec. 1, issued a permanent injunction restraining the city of Denver from letting the contract for the erection of its $5,000,000 city and county building until it has all money on hand to pay the bills. The injunction was sought by Peter Bossie, a local contractor. The case has been appealed to the State Supreme Court. Judge Moore stated that he would not consider any new trial, but gave the city thirty days to appeal to the high court. The basis for his ruling is:

"The city and county of Denver can legally contract for and cause to be constructed a municipal building in any of the following manners:

"1. By a vote of the taxpaying electors authorizing the construction of the building and a bond issue to be created providing the payment for the entire contract sum.

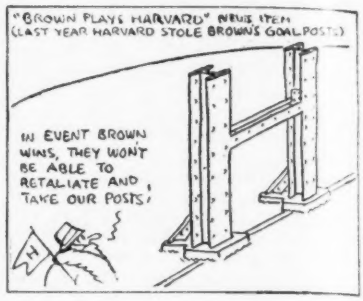
"2. By a contract for a specific and definite part of the building.

"3. By an appropriation in conformity with the statutes, charter and ordinances of the aggregate contract sum and a contract executed thereafter.

"None of these methods has been followed in the present case."

RANDOM LINES

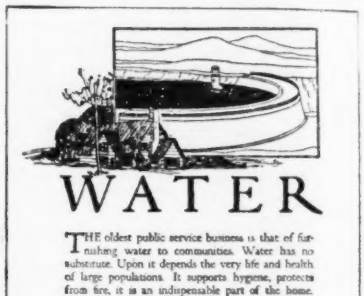
Referred to the A.I.S.C.


"BROWN PLAYS HARVARD" NEWS ITEM
(LAST YEAR HARVARD STOLE BROWN'S GOAL POSTS)
IN EVENT BROWN WINS, THEY WON'T BE ABLE TO RETALIATE AND TAKE OUR POSTS!

The New York *World* artist suggests a new market for structural steel.

* * *

Why Is an Arch


WATER
THE oldest public service business is that of furnishing water to communities. Water has no substitute. Upon it depends the very life and health of large populations. It supports hygiene, protects from fire, it is an indispensable part of the home.
... Demand for water never ceases, properties of waterworks systems endure for generations. Well selected securities of water companies which are financed by conservative investment banking houses deserve a place in every well rounded investment list.
HUNTER, DULIN & CO.
Investment Securities
256 MONTGOMERY STREET, SAN FRANCISCO

Sooner or later these advertisement engineers are going to put over this reversed arch dam idea. Here is another one.

* * *

At Last the Perfect Storage Battery

"Officials of the Electric Bond and Share Co. of New York City, of which the Carolina Light and Power Company is a subsidiary, a short time ago consummated a large real estate deal whereby they have gained control of five acres of land, just outside of Canton on the Pigeon River, and will at an early date begin erection of five large distributing tanks for electric power. These tanks and other equipment will cost around $100,000 it is estimated.

"The storage tanks weigh around 100,000 pounds each. Five are to be erected, thereby assuring electric power users of an unlimited supply, since power may be backed up from any point where these tanks are in operation."—Special dispatch to the Asheville, N. C., *Citizen*.

Engineering Societies

Calendar

Annual Meetings

AMERICAN ROAD BUILDERS ASSOCIATION, New York City; Annual Convention and Road Show, Chicago, Ill., Jan. 10-14, 1927.

AMERICAN ENGINEERING COUNCIL, Washington, D. C.; Annual Meeting, Washington, D. C., Jan. 12-15, 1927.

SOCIETY OF AMERICAN MILITARY ENGINEERS, Washington, D. C.; Annual Meeting, Washington, D. C., Jan. 17, 1927.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York City, Jan. 19-21, 1927.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; Annual Convention, Asheville, N. C., Jan. 24-28, 1927.

ENGINEERING INSTITUTE OF CANADA, Montreal; Annual Meeting, Quebec, Feb. 15-17, 1927.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Meeting, Chicago, Ill., Feb. 22-24, 1927.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Ill.; Annual Convention, Chicago, Ill., March 8-10, 1927.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Chicago, Ill., May 9-12, 1927.

The Iowa Section of the American Society of Civil Engineers, at its annual meeting in Des Moines, Ia., on Nov. 23, elected the following officers: President, O. W. Crowley; vice-president, A. H. Fuller. R. B. Kittredge, Iowa City, Iowa, who was re-elected secretary, presented a report on the Philadelphia conference of the local sections. T. Chalkley Hatton spoke on the work of the Society's board of direction and Dean C. C. Williams, of Iowa University, gave a talk on "The Present Urban Railway Situation."

Personal Notes

E. L. BRUNER, vice-president and chief engineer of Hamm & Grant, Inc., architects and engineers, Los Angeles, Calif., has been made a member of the firm, and the name of the firm has been changed to HAMM, GRANT & BRUNER. Under this name the firm will continue its work in the design and erection of industrial and commercial buildings. Mr. Bruner was formerly structural designer with the California State Harbor Commission and chief structural designer for the Spreckels Sugar Co. at San Francisco.

R. E. DOUGHERTY, engineering assistant to Vice-President R. D. Starbuck of the New York Central R.R., has been promoted to engineering assistant to the president of the New York Central Lines, with headquarters in New York City, becoming engineering adviser on matters covering the whole system. Mr. Dougherty has been progressively assistant engineer on grade-crossing elimination and yard design, resident engineer in charge of construction in the Eastern District, assistant district engineer, and district engineer in the New York Central system. In 1918 he was made designing engineer for the lines east of Buffalo, and in 1924 began special enginering work in the vice-president's office.

JAS. H. ELKINS CONSTRUCTION CO. announces the opening of offices at 1111-1112 Martin Building, Birmingham, Ala., to handle structural steel erection for office buildings, hotels, industrial buildings, tanks, and bridges.

W. H. CHACE, hydraulic engineer, has been retained by the city of Winnipeg, Man., to make a hydraulic survey of the Winnipeg River, to ascertain its possibilities as a source of electric power.

MEYER FRIDSTEIN, formerly general superintendent for G. H. Gottschalk Co., contractor, Chicago, has severed his connection with that company and announces the organization of his own company, Fridstein & Co., located at 111 West Washington St., Chicago, to specialize in the building and financing of large commercial projects, Mr. Fridstein, its vice-prseident and superintendent, having been connected with the construction of many large hotels and theaters.

MARTIN A. PRESTON, for the past four years chief engineer of construction with The Martin & Krausmann Co., general contractors, Detroit, Mich., has resigned to give his attention to personal business affairs; no definite announcement is given now concerning his future business identity except that it will be allied with building construction and industrial activities. Mr. Preston was formerly a member of the firm of Brown, Preston & Derrick of Detroit conducting an extensive practice of architecture and engineering.

GEORGE W. CURTIS, assistant superintendent on the Pittsburgh division of the Pennsylvania R.R., has been promoted to superintendent of the Norfolk division, with headquarters at Cape Charles, Va. Mr. Curtis is a graduate of Princeton University and his service has been with the Pennsylvania R.R. on engineering, maintenance and valuation work.

Obituary

WALDO C. BRIGGS, of Scarsdale, N. Y., who was engineering superintendent for Henry Steers, Inc., contracting engineer, of New York City, and an experienced subway construction engineer, dropped dead Dec. 13 of heart disease as he stepped from an elevator in the City Hall in Jersey City, N. J. Mr. Briggs was associated with H. C. Sanford in charge of the construction of the original Interborough subway from Grand Central Station through 42nd St. to Broadway and up to 47th St. He had charge of the Sunnyside Yards improvement of the Long Island R.R.; and he directed the excavation for the New York City station of the Pennsylvania R.R. between 32nd and 33rd Sts. Mr. Briggs was a graduate of Yale University and was 56 years of age.

EVERETT N. LARRY, Longview, Wash., bridge and dock engineer for the Long-Bell Lumber Co., and formerly employed by Hill, Mock & Griffin in Tacoma, died Nov. 30 in a hospital in Portland, Ore.; he was critically ill but a few days but had been in ill health for some time. Mr. Larry designed and supervised the construction of the public docks and the Long-Bell docks on the Columbia River at Longview, the large pioneer bridge across the Cowlitz River, and bridge work for the Longview, Portland & Northern Ry., and many buildings.

JAMES G. EDWARDS, Fort Collins, Colo., for nearly fifteen years county surveyor and engineer of Larimer County, Colorado, died Dec. 8 from cancer induced by a throat affection; he was 42 years of age.

DR. DANIEL CARHART, professor emeritus of engineering at the University of Pittsburgh, died Dec. 8, aged 87 years. Dr. Carhart graduated from the Polytechnic College of Pennsylvania in 1859, practiced civil engineering until 1868, when he became professor of civil engineering at Polytechnic College. In 1892 he joined the faculty of Western University, now the University of Pittsburgh; since 1908 he had been professor emeritus of that institution. He was the author of a surveying textbook and an engineering field book, and was an advisory member of the Board of Civil Commissioners at Washington, in connection with examinations for civil engineers for the Interstate Commerce Commission.

CHANDLER WITHINGTON, for twenty years chief engineer of the New York City Department of Finance and for more than forty years in the service of the city, died Dec. 13, aged 66 years. After graduation from Princeton University in 1882 Mr. Withington entered the engineering service of the New York Park Department, changing in 1886 to the Finance Department, of which he was made chief engineer in 1906.

FRANK E. BRACKETT, retired civil and mining engineer, died Dec. 11 at his home in Cumberland, Md. He was a native of Somerville, Mass., and a graduate of Harvard. His first big undertaking was the construction of the Sesquihoning tunnel in Pennsylvania; he was later superintendent of the Lehigh Coal and Navigation Co., and manager of the Maryland Coal Co. In the Civil War he joined the United States Navy and served on blockade running in the Gulf of Mexico.

PARKER C. CARSON, of Denver, Colo., federal highway engineer, died at Alamosa, Colo., Dec. 5 after a short illness from pneumonia. Mr. Carson was born in Delaware in 1884 and went to Colorado fifteen years ago. Before joining the federal bureau he was an assistant state highway engineer.

Construction Equipment and Materials

A SECTION DEVOTED TO WHAT THE MANUFACTURER IS DOING FOR THE ENGINEER AND CONTRACTOR

Roller Bearings Installed on Railway Equipment

The Chicago, Milwaukee & St. Paul Ry. has recently placed an order with the Timken Roller Bearing Co., Canton, Ohio, for roller bearings to be installed on 64 new Pullman cars and 63 cars owned by the railroad. Roller bearings for use on heavy tractive equipment have been considered and discussed for many years, but no satisfactory bearing had been found. Among the advantages which are said to be expected of roller bearings as applied to railway passenger cars are reduced train resistance, easy handling in starting long trains, easier riding equipment, elimination of hot-boxes, and a saving in lubricants.

Concrete Road Yardage

For November the square yardage included in concrete pavement contract awards, according to the Portland Cement Association, were: 3,230,838 for roads; 2,137,223 for streets; and 226,860 for alleys; or a total for the month of 5,594,921 sq.yd.

The accompanying table summarizes the statistics for the current year:

SQUARE YARDS OF CONCRETE PAVEMENT AWARDED DURING 1926

Month	Roads	Streets	Alleys	Total All Classes
Jan....	2,161,415	1,410,201	57,218	3,628,834
Feb....	2,726,611	2,010,941	274,836	5,012,388
March.	4,662,885	3,050,630	224,879	7,938,394
April...	8,758,195	4,324,729	479,763	13,562,687
May....	8,910,678	4,619,195	507,250	14,037,123
June...	10,973,452	5,999,859	524,572	17,317,883
July...	5,662,841	4,865,421	327,313	10,855,575
Aug....	6,594,150	6,293,849	360,991	13,248,990
Sept...	3,736,005	4,342,265	299,350	8,377,620
Oct....	4,223,517	2,967,800	336,451	7,527,768
Nov....	3,230,838	2,137,223	226,860	5,594,921
Totals	61,460,587	42,022,113	3,619,483	107,102,183

Southern Clay Products Association Formed

At a meeting in Macon, Ga., recently nine manufacturers of brick and hollow tile formed the Southern Clay Products Association whose purpose is to "educate the public in the great advantages of burned clay products as building materials and thereby increase their use." It is said that many manufacturers have not felt that such an association was practical until recent years because of the varying specifications used by different companies. Now, it is announced, all the manufacturers who are members of the association are strictly adhering to the specifications prescribed by the United States Bureau of Standards for standard brick and hollow tile.

Clarence Seavers was appointed executive secretary, with headquarters in Macon. He will direct the research and promotive work of the association. W. E. Dunwody, president, Standard Brick & Tile Co., Macon, Ga., was elected president of the association. Charter members of the Southern Clay Products Association include the following companies: Columbus Brick & Tile Co., Columbus, Ga.; Gamble & Stockton Co., Jacksonville, Fla.; Dixie Brick Co., Columbus, Ga.; Bickerstaff Brick Co., Columbus, Ga.; Kaolin Brick Co., Columbus, Ga.; Merry Bros., Augusta, Ga.; Georgia-Carolina Brick Co., Augusta, Ga.; McKenzie Brick Co., Augusta, Ga.; and the Standard Brick & Tile Co., Macon, Ga.

Motion Pictures on Asphalt Paving

Two motion pictures, one showing sheet asphalt construction and the other asphalt penetration macadam, are being loaned by the Texas Co. asphalt sales department, 17 Battery Place, New York City, without charge. These pictures are suitable for presentation before engineering bodies, chambers of commerce, students of highway building practice, etc.

Business Notes

CHAIN BELT CO., Milwaukee, announces the appointment of three new distributors for their Rex mixer line: West Virginia Mine Supply Co., Clarksburg, W. Va.; Builders Supply Co., Shreveport, La.; and George R. Feldmann Co., Wilkes-Barre, Pa.

JOSEPH T. RYERSON & SON, INC., Chicago, has purchased the warehouse property of the Bourne-Fuller Co., Cleveland. The Bourne-Fuller Co. will concentrate on its business of manufacturing steel products. The property purchased consists of a group of warehouses with 200,000 sq.ft. of ground area. Included with the plant are about 12,000 tons of structural steel. The Ryerson company will add to the facilities and increase the size and range of stock carried. This is the ninth Ryerson plant, the others being located at Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Buffalo, Boston and New York.

PITTSBURGH TESTING LABORATORY has just opened a new Detroit branch for the purpose of testing cement, concrete, sand, stone and allied material. Compression tests up to 200,000 lb. are possible. The address is 242 West Lafayette Boulevard.

CENTRAL FOUNDRY CO., New York City, manufacturer of universal cast iron pipe, announces the appointment of Fred V. Sohle, as sales representative for the southwestern states with offices in the Praetorian Building, Dallas, Texas.

MUNDY SALES CORP., New York City, announces the appointment of George W. Ziegler Machinery Co., 528 First Ave., Pittsburgh, as its exclusive distributor in that territory.

SULLIVAN MACHINERY CO., Chicago, announces that it has disposed of its stone channeler business to the New Albany Machine Mfg. Co., New Albany, Ind. Orders for spare parts and for new machines should be addressed to the latter company.

WILLIAMS FORM CLAMP CO., INC., Chicago, announces that a reorganization has been effected in which D. F. Crimmins becomes president, O. M. Lux, vice-president, in charge of sales, Otis Shaw, secretary, and Joseph E. Novak, treasurer.

RIVET-GRIP STEEL CO., Cleveland, Ohio, has just opened a new fabricating plant at Canonsburg, Pa.

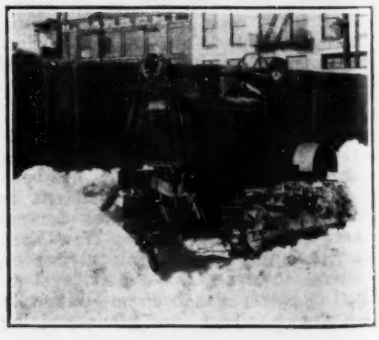
BUDA CO., Harvey, Ill., has recently made several changes in its sales personnel. John P. Mahoney, formerly director of sales of the automotive, power plant, and industrial divisions, has had added to his duties that of general supervision of service activities; Walter Petty, formerly chief engineer, Service Motor Truck Co. and Maccar Truck Co., will be in active charge as manager of the service department. Guy B. Wright, sales manager of the automotive division, will have charge of sales in the bus, truck, taxicab and marine divisions, while R. K. Mangan has been made sales manager of the industrial and power plant divisions.

UNIVERSAL CRANE CO., Cleveland, Ohio, announces the opening of two new district sales offices, one in Atlanta, Ga., with E. W. Matthews as district manager and the other in Philadelphia with C. G. A. Schmidt, Jr., as district manager.

New Developments

Fordson Crawler Unit Altered for Snow Plow Attachment

In order to make its Fordson crawler tractor adaptable for highway snow removal, the George Haiss Mfg. Co., Inc., New York City, has arranged with the Good Roads Machinery Company, Kennett Square, Pa., to make a snow plow



specially for use with the tractor. The only change made in the tractor is the substitution of a crossbar in place of the spring, the crossbar being equipped with two lugs which take the push bars of the snow plow. The creeper treads are equipped with angle cleats 2 in. high.

The plow illustrated is an 8 ft. snow plow equipped with a raising and lowering device which can be operated by the tractor operator. The "traxion chassis," as the unit is called, is attached to a Fordson tractor without any change to the tractor other than the removal of the wheels.

Huge Crushers Built to Take a 70-Ton Carload of Copper Ore

What are claimed to be the largest ore crushers ever built are now being shipped from the plant of the Allis-Chalmers Mfg. Co. in Milwaukee. In designing these machines, the engineers were not only confronted with the problem of designing a crusher larger than any other yet built, but they had to take into account the question of shipping them over 5,000 miles under very unusual conditions. The crushers were built for the Chile Exploration Co., a subsidiary of the Anaconda Copper Mining Co. for installation at Chuquicamata in the Andes Mountains of Chile.

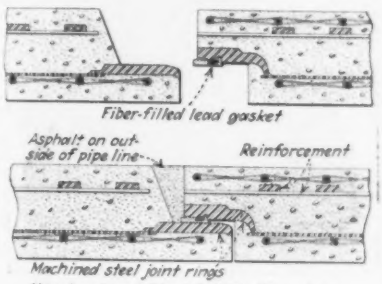
The illustration gives some idea of the size of the crushers. Each machine weighs 500 tons and is built almost entirely of steel. Two hopper openings each 5 ft. across permit a load of ore weighing 70 tons to be dumped into the crusher at one time. The crusher will handle pieces of ore weighing as much as 7 tons. The ore will be reduced to a 12-in. product. Each crusher's capacity is estimated at from 2,000 to 2,500 tons of ore per hour.

Shipping these machines will be a problem in itself. The largest pieces weigh about 60 tons each. Shipment by rail to New York will be taken care of by 25 freight cars. At New York, the Chile Exploration Co.'s steamer, "Chilcop," especially equipped with heavy derricks, will take the crushers transporting them through the Panama Canal to Mejillones, Chile, where, because of lack of harbor, the crushers must be transferred to lighters, towed onto the beach, and placed on cars on a 30-in. narrow-gage railroad. The mine is at an altitude of 9,500 ft. and because of sharp curves special railway cars have been built to handle the machines.

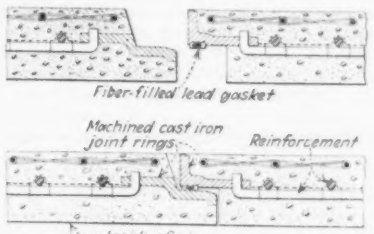
New Self-Caulking Lead and Steel Joint for Concrete Pipe

In connection with the construction of the new pipe line for the Providence, R. I., water supply and the laying of some 17,000 ft. of 36 in. reinforced concrete pipe by the City of New York, the Lock Joint Pipe Co., Ampere, N. J., has developed an improved self-caulking lead and steel joint for its reinforced concrete pressure pipe. The joint provides in addition to the benefits of a self-caulking joint the further advantage that it may be mechanically caulked on the outside at any later time should necessity arise. The Providence pressure line of about 36,000 ft. total length will include 12,000 ft. of 48 in. pipe using this lead and steel joint. The New York contract is for new construction in the Borough of Queens and all pipe will use the new joint.

The Lock Joint Pipe Co. has heretofore used two types of joint, known respectively as the lead and iron joint, and the lead and steel joint. The lead and steel joint is for the larger sizes of pipe ranging from 36 in. to 108 in. in diameter and is mechanically caulked from the inside. The lead and iron joint is a self-caulking type used on pipe ranging in sizes from 12 in. to 48 in. in dia. The new lead and steel joint is an outgrowth of the lead and iron joint, and is thought to eliminate some few disadvantages, either actual or potential, that were inherent in the old joint. The illustration shows a



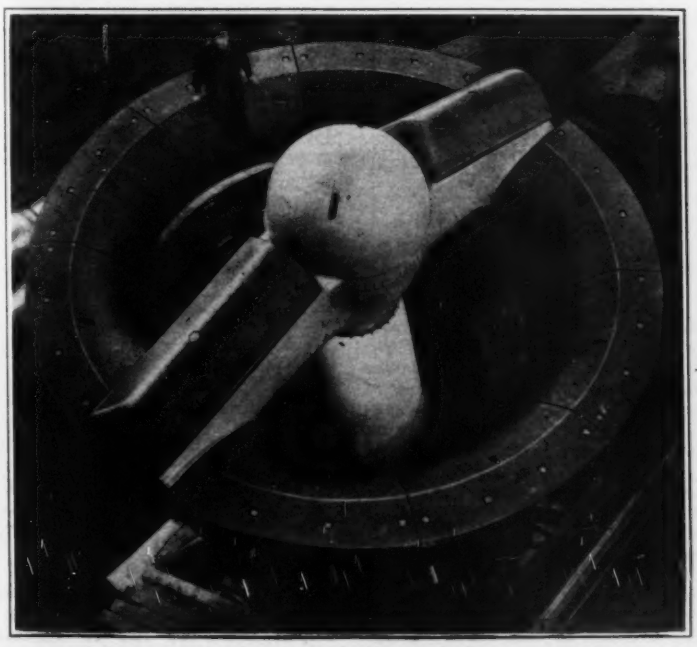
New Lead and Steel Self-Caulking Joint



Lead and Iron Self-Caulking Joint

detail of the new joint and also the old lead and iron joint. In the new joint the cross section of steel bands in both the bell and spigot ends averages about 3¼ in. The amount of lead in the gasket has been materially increased over that in the lead and iron joint as may be seen by comparing the two details. The lead gasket is fiber filled as shown and permanently held in the bell end. The steel bands are welded and then stretched to exact diameters. This procedure also provides a rigorous test for the weld.

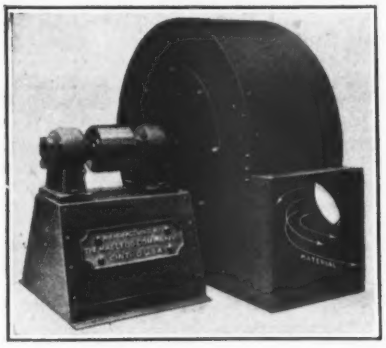
This joint is claimed to be sufficiently flexible to provide for any movement likely to occur in the pipe line. In laying the pipe line the pipe sections of 12 ft. lengths are jacked together, the lead being squeezed to a tight fit in the annular opening. The wedge shaped opening on the outside at each joint is finally filled with asphalt which may be removed for later caulking of the lead should this ever become necessary.


CRUSHER THAT WILL REDUCE 7-TON PIECES OF ORE TO A 12-INCH PRODUCT

New Exhaust Conveying-Fan Will Not Clog

A new exhaust fan manufactured by the Macleod Co., Cincinnati, Ohio, has a projected inlet adjacent to the discharge outlet instead of a center inlet as contained in many fans. The material to be conveyed is thus immediately discharged without passing through the wheel or around the housing. This feature permits the wheel to be in balance at all times and also eliminates any possibility of the wheel

becoming clogged. The life of the fan is also materially increased. These fans will handle any kind of material that can be conveyed by air. Suction is created by centrifugal pressure, the air being forced to the side of the housing opposite the wheel and the pressure of the air passing the pro-



jected inlet creates a high suction. Pressures up to 12 in. are available. The fans are adjustable and reversible, each machine being adjustable to over 30 different combinations. They are constructed almost entirely of steel.

New Publications

Industrial Heating—BUFFALO FORGE CO., Buffalo, N. Y., devotes its catalog No. 466 to industrial heating installations using its unit heaters. In the catalog are described the various types of heaters with the suggested applications of each.

U. S. Maps and Charts—W. & L. E. GURLEY, Troy, N. Y., has published a 20-p. booklet explaining the organization and activities of the Board of Surveys and Maps of the Federal Government; it also tells how the maps and charts are made and where they are obtainable. The booklet should prove interesting to topographical men and engineers in general.

Sluice Gates—C. E. BUTCHART CO., Denver, Colo., devotes its catalog No. 16 to head gates, sluice gates, hoists and lifts as used on irrigation and drainage systems and in connection with water works, sewage disposal, filtration and hydroelectric plants. Data necessary for ordering are given, after which a separate page is devoted to line drawings and dimensions for each different type of equipment. In the back of the booklet are given a number of illustrations of installations.

Lime on Earth Road Construction—NATIONAL LIME ASSOCIATION, Washington, D. C., has issued a bulletin 317 entitled "Out of the Mud With Lime," in which the treating of earth roads with lime is discussed. The method of treatment, the amount of lime required, and other uses on earth roads to which lime may be applicable are given. Illustrations show stretches of road upon which lime treatment has been used.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

This Week's Contracts—Week Ago—Same Week Last Year

THE money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, religious and other buildings. Under the head of excavations are included drainage, irrigation, levee, river and harbor projects.

Money Value of Contracts Let—Entire U. S.

Week Ending	Public Work	Private Work	Total Contracts
Dec. 16, 1926	$16,559,000	$36,596,000	$53,155,000
Dec. 9, 1926	21,088,000	25,913,000	47,001,000
Dec. 17, 1925	17,142,000	35,444,000	52,586,000
Heaviest Week			
1926, Mar. 11	13,029,000	73,613,000	86,642,000
1925, Sept. 3	16,215,000	69,424,000	85,639,000
January 1 to date			
1926	1,057,743,000	1,734,067,000	2,791,810,000
1925	1,011,128,000	1,459,860,000	2,470,988,000

Sufficient Construction Proposed to Extend High Volume Rate Well Into 1927

Weak Spots In Last Half of Current Year Confined to Residential Building and Industrial Jobs Around $40,000

ALL classes of construction, with the exception of industrial and residential have shown no more than seasonal variations from month to month, in money value of contracts let throughout the current year.

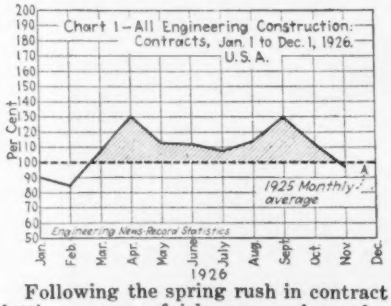


Chart 1—All Engineering Construction: Contracts, Jan. 1 to Dec. 1, 1926. U.S.A.
Per Cent
1925 Monthly average
Engineering News-Record Statistics
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec
1926

Following the spring rush in contract letting came a fairly even volume for the summer months, taking all classes together. Many projects, held out of the market during the warm season were awarded in the fall, making another heavy rise in lettings at that time.

The accompanying charts show movements in 1926 monthly contract totals, compared with the 1925 monthly average.

On three occasions during the year, industrial building awards of $40,000 value and over dropped below the 1925 monthly average in this class. These recessions occurred in June, August and October, respectively. Small factory construction, however, remained consistently above the 1925 monthly average during the first ten months of 1926.

Residential construction recovered from an unseasonal slump which happened in July, and is still slightly above the 1925 monthly average for this class.

With the 1926 average construction cost only 0.6 per cent above that of 1925 and approximately the same number of building trades mechanics employed, the present momentum can be depended upon to carry the high volume

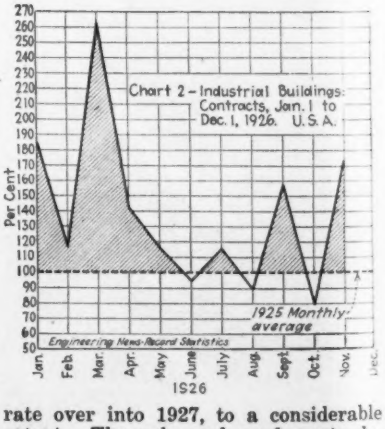


Chart 2—Industrial Buildings: Contracts, Jan. 1 to Dec. 1, 1926. U.S.A.
Per Cent
1925 Monthly average
Engineering News-Record Statistics
Jan Feb Mar Apr May June July Aug Sept Oct Nov
1926

rate over into 1927, to a considerable extent. The only real weak spots developed thus far are in residential building and industrial projects worth around $40,000.

The erratic course of Chart 2 is due to large single awards during the months showing the high points. More than a third of these were big power plant jobs.

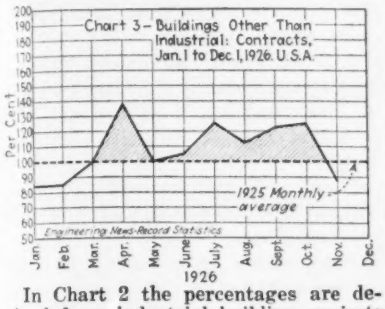


Chart 3—Buildings Other Than Industrial: Contracts, Jan. 1 to Dec. 1, 1926. U.S.A.
Per Cent
1925 Monthly average
Engineering News-Record Statistics
Jan Feb Mar. Apr May June July Aug. Sept. Oct Nov Dec
1926

In Chart 2 the percentages are derived from industrial building projects of $40,000 value and over, while in Chart 3, the minimum for buildings is $150,000. The minimum values used in Chart 4 are $15,000 for waterworks, excavations, drainage, irrigation, levee, river and harbor projects and $25,000 for all other public work.

The total of proposed work in the classes covered by these charts reached $372,791,000 for November, 1926, a gain of 6 per cent over the month preceding. The total, Jan. 1 to Dec. 1, 1926, was $4,969,546,000, an increase of 14 per cent over the corresponding period in 1925.

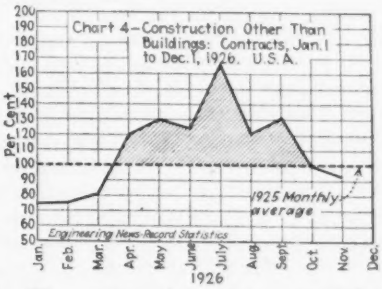


Chart 4—Construction Other Than Buildings: Contracts, Jan. 1 to Dec. 1, 1926. U.S.A.
Per Cent
1925 Monthly average
Engineering News-Record Statistics
Jan Feb Mar. Apr May June July Aug. Sept. Oct Nov Dec
1926

The states in which November gains in proposed work occurred, were as follows: Maine, New Hampshire, Connecticut, Pennsylvania, Maryland, Delaware, West Virginia, North Carolina, South Carolina, Georgia, Florida, Massachusetts, Tennessee, Ohio, Indiana, Illinois, Michigan, Minnesota, Missouri, Nebraska, Kansas, Oklahoma, Texas, Montana, Washington, Oregon, California. November proposed gained in bridges; paving jobs; industrial, commercial and public buildings.

Contractors Wanted for Florida Reconstruction Work

A financial institution writes, "We are interested in receiving the names of responsible contractors in the North who carry over the winter months organizations which might be sent to Florida where work can proceed throughout the year." Further information may be had by addressing *Engineering News-Record*, Tenth Ave. at 36th St., New York, N. Y.

Unit Prices on Highway Materials in Place

COSTS of structural concrete and reinforcing steel in place, as well as surfacing and excavating on various public highway jobs let during 1926, throughout the South and West, are shown in the following tabulation.

Data are given on grading and draining operations, bridge construction and six different forms of road surfacings. Average number of miles over which materials were hauled to site of job are included and also the average hourly wage paid common laborers on each project. In all, twenty-three counties in seven states are covered.

BID PRICES, BUREAU OF PUBLIC ROADS, U. S. DEPARTMENT OF AGRICULTURE

County	Contract Let to	Type	Unit Prices Bid—Materials in Place: Surfacing Sq. Yds.	Surfacing Unit Price	Excavation Cu. Yds.	Excavation Unit Price	Structural Concrete 1-2-4 Cu. Yds.	Structural Concrete 1-2-4 Unit Price	Steel Reinforcing Lbs.	Steel Reinforcing Unit Price	Average Haul, Mi.	Average Hourly Wage, Common Labor
ALABAMA												
Montgomery	R. G. Lasseter & Co., Montgomery, Ala.	Bit. Conc.	72,500	$1.18	85,012	$0.30	....	.....	82,252 23,400†	$0.06 .07	...	.....
GEORGIA												
Dekalb	McDougal Const. Co., Atlanta, Ga.	Bit. Conc.	13,482	2.55	8,573	.40	....	.....	.....	.....	‡	$0.20
IOWA												
Plymouth	J. H. Hill & Co., Early, Ia.	.....	7,880	.35	19,000	.18	....	.....	.....	.....	...	.35
KANSAS												
McPherson	Shuss & Henderson, Larned, Kan. (Drainage structures)	Campbell & Lockenmier, Miltonvale, Kan. (Excavation)	.....	.....	30,966	.28	440	.....	49,703 47,433†	.05 .06½	3	.40
NEBRASKA												
Adams	A. C. Lund, Kearney, Nebr.	Gravel	266,500	.14½	.....	.....	....	.....	.....	.....	5	.35
Gosper	Union Const. Co., Kearney, Nebr.	Gravel	86,000	.17	.....	.....	....	.....	.....	.....	2	.30
Custer	Allied Contract, Inc., Omaha, Nebr.	Gravel	116,500	.17	.....	.....	....	.....	.....	.....	3	.30
Dawson	Reel & Kennedy, Dalton, Nebr.	Gravel	248,100	.10	.....	.....	....	.....	.....	.....	...	.30
Ralan	Yant Const. Co., Omaha, Nebr.	Gravel	41,600	.15	.....	.....	....	.....	.....	.....	2	.35
Case	Yant Const. Co., Omaha, Nebr.	Gravel	80,400	.21	.....	.....	....	.....	.....	.....	4	.35
Nuckolls	Kochler Lbr. & Coal Co., Sterling, Nebr.	Gravel	49,800	.23	.....	.....	....	.....	.....	.....	2	.35
Kearney	E. Bowker, Kearney, Nebr.	Gravel	34,000	.10	.....	.....	....	.....	.....	.....	3	.35
Cherry	Roberts Const. Co., Lincoln, Neb.	Gravel	134,561	.21	.....	.....	....	.....	.....	.....	6	.40
TENNESSEE												
Tipton, Shelby	Peerless Construction Terre Haute, Ind.	Bit. Conc.	96,272	2.15	.....	.....	....	.....	.....	.....	2	25
Shelby	C. J. McFarlin & Co., Keeling, Ky.	Grad. & Dr.	.....	.....	.....	.....	619	22.00	64,706	.06	4	25
Shelby	Boyd & Co., Hickory, N. C.	Bridges	.....	.....	.....	.....	1,275	22.60	146,756	.05½	4	.25
Dyer & Lauderdale	Kohn F. Kelly Co., Terre Haute, Ind.	Pl. Cement	219,059	2.16	.....	.....	....	.....	.....	.....	2½	.25
Greene	Galloway & Fisher, Lenoir City, Ind.	Pl. Cement	120,467	2.49	.....	.....	....	.....	.....	.....	3	.25
Bedford	Boyd Williams, Murfreesboro, Ind.	Macadam	.....	.....	.....	.....	644	22.00	91,458	.06	4	.25
Obion	O. E. Cresop, Humboldt, Ind.	Grad & Dr.	.....	.....	66,325	.29	495	21.00	55,460	.06	3½	.25
Obion	W. M. Hill & Sons, Fulton, Ky.	Bridges	.....	.....	.....	.....	1,301	18.50	111,756	.04	3½	.25
Bradley	Gamble Const. Co., Chattanooga, Tenn.	Pl. Conc.	97,953	2.34	.....	.....	....	.....	.....	.....	4	.25
WASHINGTON												
Okanogan	Cole & Strong, Riverside, Tenn.	Cr Rock	.....	.....	29,370 3,220	.25 1.20*	38 67	25.00	320	.08	1½	.50

* Rock excavation. † Structural steel. ‡ 1-3-6.

Weekly Construction Market

BUYING of railway material, particularly steel rails, is probably responsible for the increase of 3 per cent or more in unfilled steel tonnage on books of the U. S. Steel Corporation, Nov. 30, 1926.

The November ingot output, all companies combined, was 9 per cent under production for the month preceding and 5 per cent below the corresponding period in 1925. Despite holiday dullness in the steel market, bookings of structural steel orders appear in good volume.

Common building brick are perceptibly firmer as to price in the New York market, owing to scarcity growing out of exceptionally early freezing of the waterways. No disturbance of the brick price situation is noted in the other large industrial centers reporting.

The linseed oil market has turned downward again with a drop of 1½c. per gal. (7½ lb.) at Minneapolis, since last week. Dallas prices declined 8c. and Atlanta 9c. per gal. at the same time.

Hollow building and partition tile shows firmness with rising tendencies in the Southwest, while the same is true of the New York district, with the exception that in the latter actual change in price schedules has not yet taken place.

Steel-mill prices on the principal hot-rolled products remain pegged at $2 per 100 lb. for shapes and reinforcing bars and $1.90 on plates.

Concreting materials, lumber, lime and brick hold at last week's quotations in the nine districts.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb	$3.34	$3.80	$4.15	$3.10	$3.35	$3.87½	$3.30	3.15	$4.00
Structural rivets, 100 lb	4.20	3.80	4.75	3.50	3.75	4.65	5.00	4.00	5.50
Reinforcing bars, ¾ in. up, 100 lb	3.24	2.80	3.25	2.30@2.50	2.87½	3.77½	2.95	3.10	3.25
Steel pipe, black, 2½ to 6 in. lap, discount	48%	54%	54%	51%	54.25%	41%	49.7@54.1%	45%	37.83
Cast-iron pipe, 6 in. and over, ton	50.60	+42.75	56.00	47.20	53.00	64.00	49.00	55.00	55.00
Concreting Material									
Cement without bags, bbl	2.50@2.60	2.35	2.05	2.10	2.32	2.85	2.31	2.65	1.15
Gravel, ¾ in., cu.yd	1.75	1.90	2.38	1.85	1.65	1.90	1.80	1.25	1.50
Sand, cu.yd	1.00	1.60	2.00	1.65	1.25	1.00	1.40	1.25	1.25
Crushed stone, ¾ in., cu.yd	1.94	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	2.00
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	62.00	34.00	56.00	40.50	38.75	34.75	27.00	25.00	50.00
Lime, finishing, hydrated, ton	18.20	23.50	19.00	20.00	25.50	24.00	25.50	24.00	21.00
Lime, common, lump, per bbl	2.10@3.00	1.50	1.82	1.50	1.70	2.70	1.60	2.80	10.00
Common brick, delivered, 1,000	20.40@22.40	10.50	14.10	12.00	13.75	9@10	15.00	15.00	20.25
Hollow building tile, 4x12x12, per block	Not used	.0895	+.112	088	.076	.075	.....	.09	.10
Hollow partition tile 4x12x12, per block	.1027	.0895	+.112	.088	.076	.075	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal.	.86¼	—.90¾	—1.10	.84	—.92¼	1.06	.98	1.12	1.05
Common Labor									
Common labor, union, hour	90⅝	30		90	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	25	30@.50	....	45@.60	.40@.45	.50	.....	—.25@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent. L.c.l. is less than carload lots.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Reinforcing bars (billet steel) and shapes delivered to job in less-than-carload lots.

Labor — Cement and concrete laborers' rate, $1.06¼; building laborers, 90⅝c.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b.; price on fir is quoted instead of pine. Reinforcing bars (billet steel) f.o.b. warehouse in carload lots; shapes, less-than-carload lots.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. Bars (billet steel) at warehouse in carload lots; shapes, less-than-carload lots.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of Dec. 2 the next on Jan. 6.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net. Bars (billet steel) and shapes, l.c.l.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Dallas quotes lime per 180-lb. bbl. Cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. Bars (billet steel) and shapes, l.c.l.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers. Bars (billet steel) and shapes, less-than-carload lots.

Montreal quotes on fir lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 99.90). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½ in., $37.83. Bars (billet steel) and shapes, less-than-carload lots.

Business Briefs

Call money quoted at 5 per cent, Dec. 14; year ago, 5 per cent.

Time loans: 60 to 90 days, 4⅝; 4 to 6 months, 4⅝@4¾ per cent.

Commercial paper: Best names, 4@6 mo., 4½; others, 4¾ per cent.

On Dec. 1, 1926

E. N.-R. Construction Cost Index Number 210.80

E. N.-R. Construction Volume Index Number 211

For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month